Early Journal Content on JSTOR, Free to Anyone in the World

This article is one of nearly 500,000 scholarly works digitized and made freely available to everyone in the world by JSTOR.

Known as the Early Journal Content, this set of works include research articles, news, letters, and other writings published in more than 200 of the oldest leading academic journals. The works date from the mid-seventeenth to the early twentieth centuries.

We encourage people to read and share the Early Journal Content openly and to tell others that this resource exists. People may post this content online or redistribute in any way for non-commercial purposes.

Read more about Early Journal Content at http://about.jstor.org/participate-jstor/individuals/early-journal-content.

JSTOR is a digital library of academic journals, books, and primary source objects. JSTOR helps people discover, use, and build upon a wide range of content through a powerful research and teaching platform, and preserves this content for future generations. JSTOR is part of ITHAKA, a not-for-profit organization that also includes Ithaka S+R and Portico. For more information about JSTOR, please contact support@jstor.org.

Journal of the Society of Arts.

◆

FRIDAY, APRIL 9, 1869.

Announcements by the Council.

◆

Ordinary Meetings.

Wednesday Evenings at eight o'clock :—

April 14.—"Spain Commercially and Economically Considered." By E. M. Underdown, Esq., Barrister-at-law.

April 21.—"On Trade Marks." By W. Wybrow Robertson, Esq.

April 28.—"On the Duties of the Architect with reference to the Arrangement and Structure of a Building." By Roger Smith, Esq. On this evening Sir Digby Wyatt will preside.

May 5. "On the Formation of Industrial Settlements in our Colonies." By Col. Francis C. Maude, C.B.

FINAL EXAMINATIONS, 1869.

In order to avoid holding these Examinations on the same evenings as those of the Department of Science and Art, it has been decided to hold them, in 1869, on the evenings of

TUESDAY, the 20th APRIL,
WEDNESDAY, the 21st „
THURSDAY, the 22nd „
FRIDAY, the 23rd „

From 7 p.m. to 10 p.m., instead of on the 27th, 28th, 29th, and 30th April, as announced in the Programme of Examinations for 1869.

Cantor Lectures.

The Third Course of Cantor Lectures for the present Session will be "On Applied Mechanics," and will consist of Four Lectures, to be delivered by John Anderson, Esq., C.E., Superintendent of Machinery to the War Department, as follows :—

Lecture I.—Monday, April 12th.

Applied Mechanics in relation to Art and Science.

Lecture II.—Monday, April 19th.

Applied Mechanics in relation to Natural Properties of Materials.

Lecture III.—Monday, April 26th.

Applied Mechanics in relation to Natural Laws in processes.

Lecture IV.—Monday, May 3rd.

Applied Mechanics in relation to Natural Power.

Each lecture will begin at eight o'clock. These Lectures are open to Members, each of whom has the privilege of introducing two friends to each lecture. Tickets for this purpose were forwarded with last week's *Journal.*

Institution.

The following Institution has been received into Union since the last announcement :—

Oldham, Analytic Literary Institution.

Committee on India.

Six Conferences are now in course of being held for the discussion of the following subjects, viz. :—

Tea Cultivation in India.
Hill Settlements and Sanitaria.
Waste Lands in India.
Trade with Central Asia, Thibet, and South-Western China.
Indian Fibres.
Silk Cultivation and Supply.

The following evenings have been fixed for the remaining four conferences :—

Friday, April 16th.
„ April 30th.
„ May 14th.
„ May 28th.

At these Meetings the chair will be taken at 8 o'clock, and the discussion will be opened by a paper.

On Friday, the 16th inst., a paper, "On Hill Settlements and Sanitaria," will be read by Mr. Hyde Clarke, Member of the Council. The chair will be taken by Lord William Hay.

Members of the Society interested in Indian questions are invited to attend.

Piscicultural Committee.

This evening (Friday), the 9th inst., a meeting will be held, when a paper, "On Salmon Laws and Salmon Rivers," by Dr. Wm. Peard, of Bath, will be read and discussed. The chair will be taken at eight o'clock.

Members of the Society interested in Pisciculture are invited to attend.

Subscriptions.

The Lady-day subscriptions are due, and should be forwarded by cheque or Post-office order, crossed "Coutts and Co.," and made payable to Mr. Samuel Thomas Davenport, Financial Officer.

Proceedings of the Society.

◆

India Conferences.

The second of the conferences appointed to take place on Indian questions was held on Friday evening, April 2nd, Dr. Forbes Watson in the chair. The paper read was—

ON SILK CULTIVATION AND SUPPLY IN INDIA.

By P. L. Simmonds, Esq., Hon. Sec. of the Silk Supply Association.

I have been asked to open up the subject of Silk Cultivation and Supply in India by a few remarks, but when there are so many much more intimately acquainted with the subject than myself, I can scarcely tell why I have been selected to open the discussion of this very important question. It is one at least to which I have long paid attention, for it will be seen by reference to the *Journal of the Society,* that fourteen years ago in this room I spoke at some length on the subject of Indian silk production,* when Mr. Dickins read a most exhaustive paper on "The Commercial Consideration of the Silk-worm and its Products." Strangely enough that gentleman and myself, who have not been thrown together since, are now closely associated as the active agents in a Silk Supply Association recently formed in London, which has for its object the endeavouring to stimulate and extend the production of that important raw staple, on which not only depends the prosperity of thousands in this country and on the Continent, but also the comfort and well being of operatives and labourers in far distant lands.

In 1808, at a meeting of the Silk Trade, held at Weaver's Hall, it was unanimously resolved "That Bengal silk was become highly necessary in many branches of manufacture, and that from experiments lately made it is found fit for purposes to which it had not before been thought suitable."

Although our extended commerce with China and Japan has brought in largely-increased supplies from those eastern countries, and the production of silk on the continent has been greatly stimulated, the demands for the civilised world are such, that Bengal silk is more and more inquired for, and has materially improved. Much, however, yet remains to be done, both as to quantity and quality. Our total imports of silk last year were nearly seven million pounds, but this is a million and a quarter pounds less than was received in 1858.

The silk of Bengal was originally very inferior in quality and very carelessly wound. The East India Company, in 1757, sent a Mr. Wilder to improve the winding of silk, and in the year 1769, other Europeans, as drawers, winders, reelers, and mechanics. The plantations were all in Bengal, and to the southward of 26° of N. lat., for the North-west Provinces were (as stated by Dr. Royle) to be much too hot and dry for the silk worm.

Experiments were for many years made on the western side of India to introduce the culture of the silk worm, under an Italian, M. Muti, but they were abandoned, for want of success. Some excellent silk is, however, produced in Mysore, and it is probable that the culture might easily be carried on in the valleys of the Himalayas, and to these points I shall draw attention hereafter.

The Jury of the Paris Exhibition of 1855, on Silk, remarked in their Report, that the art of silk cultivation extended over the extreme portions of the Indian Empire. There skilful cultivators, seconded by large capital, have established for some years past improved establishments for reeling the silk from the cocoons. The silk shown among the other varied products of the East India Company, excited the warm attention of the Commission, and showed the great progress that had been made in reeling Bengal silk, which had been previously thought impossible, by reason of the difficulties that lay in the way of introducing the discipline necessary for the introduction of the improvements in those distant regions. Looking at this progress, who can predict the future of silk in the East. China will soon have no barrier to oppose the pacific civilizing conquests of European industry.

Messrs. Eaton and Sons inform me that the one great drawback hitherto attending Bengal silk is being rapidly decreased—namely, the manipulation of the cocoons by the natives. Now, on all sides, plantations worked by Europeans are starting up, and the natives, instead of winding off the cocoons which they produce, sell them to the proprietors of the plantation, and these being worked upon the Italian system, silk is turned out fit to compete in many respects with that of the European production; but the cocoon, being naturally a poor little thing, will never yield silk equal in nerve to the other sorts. Something may, however, be done by introducing new seed from Japan,—which, in all countries, seems to prosper well.

In their last annual statement, Messrs. Durant and Co., speaking of Bengal silk, say "The delivery is fully equal to last year, and this, with a reduction of 20 per cent. in the supply; hence a considerable reduction in the stock, and comparatively full support of the improved prices of all the finer and better classes; the lower classes are at present almost unsaleable."

The average monthly delivery of Bengal silk during the last three years was over 641 bales. The average net weight of a bale of Bengal silk is 150 lbs., but small bales weigh only 105 lbs.

The late Mr. Wentworth, in his Report to the Society of Arts on the Italian Exhibition at Florence in 1861, stated that there was received there from India and China (but principally from the former), and always in cocoons, about 984 tons annually, which at 2s. 4½d. the lb., would be worth about £241,000.

If we trace back the annual supply of Indian silk, commencing with 1820, we find that the imports into the United Kingdom in that year were 1,206,722 lbs., or nearly one-half the total quantity named. The highest import reached was 2,116,596 lbs. in 1829. It subsequently averaged about 1¼ million pounds (with one or two exceptional years) until 1853, when there was a great fall to 586,662 lbs., and the later years, up to 1859, were not very much higher, except 1854, 1855, and 1858, which years averaged about 1 million pounds. But this has to be explained by the entries made through Egypt, which swell the returns of Indian silk to from 3 to 5 million pounds; or from one-third to one-half of the total supply from all quarters.

In 1851 the quantity of silk exported from all India was 592 tons, value £619,318; 31 tons being shipped from Bombay, and all the rest from Bengal. Nearly all this was sent to England, a very little to France and the Arabian and Persian Gulf.

In 1861 the total quantity exported was 873 tons, value rather more than one million sterling. France received about 213,000 lbs. weight of this. Bombay and Bengal were still the only two producing presidencies.

The value of the manufactured silk goods exported from India has largely declined. In 1851, 634,024 pieces, valued at £355,223, were shipped, nearly all to the United Kingdom. In 1861 only 211,542 pieces, of the value of £122,787, were exported; and in 1865 the value of the silk goods exported had dropped to £106,612. The principal seats of silk manufacture in India are the cities of Peshawur, Lahore, Umritsur, Mooltan, and the capital of the neighbouring State of Bhawulpore. The silks of the latter place are considered the best, and the next those of Mooltan.

The value of the silk manufacture in the Punjab was estimated twenty years ago at over £130,000, nearly half of that sum being expended on the raw material. At Umritsur there were 2,200 shops of all descriptions interested in the silk manufactures, the fabrics turned out being valued at £40,000. At Lahore there were nearly 1,000 shops, and the value of the manufactures was £20,000. In the Mooltan and Bhawulpore districts above £30,000 worth of silk goods were turned out, and nearly as much more in the Jullundhur and other districts. Little or no raw silk appears, however, to be produced in the Punjab, a circumstance that seems singular, considering the apparent fitness of the soil, country, and climate for the cultivation of the mulberry. The raw material employed at Lahore is chiefly brought from Bokhara or Afghanistan. The raw silks of Bengal and China are also made use of, the latter being procured from Bombay.

It is not improbable that the lower districts of the Punjab were formerly silk-producing countries, as we know that in the time of Justinian silk was produced in Pirhind. A series of experiments was made a few years ago by the Government of the Punjab, with a view of ascertaining whether silkworms could be successfully reared in the plains; but the experiment was a failure; the heat and want of sufficient moisture having rendered the worms nearly unproductive.

---

* See *Journal*, Vol. iii., p. 203.

Notices regarding the extension of silk cultivation in the Punjab have, from time to time, appeared in India, and attracted considerable attention. The cultivation was originally commenced in 1862, at the suggestion of the then secretary of the Agri-Horticultural Society of the Punjab, and most liberally fostered by the local and supreme government. Reasons (on which it is unnecessary to dwell) led to the experiments being given up. Shortly afterwards Mr. H. Cope, of Umritsur, brought the fact to notice that a native had successfully carried on silk cultivation in the Goordaspoor Zillah for years. The fact induced Mr. Cope to renew his attempts in 1860, when he obtained 3½ maunds of cocoons. Lord Canning sent the silk to England, where it attracted much attention. In 1862 the Punjab government again came forward; gave Jaffer Khan 500 rupees, and 10 acres of land; also a grant of 2,000 rupees to Mr. Cope, to aid him in further attempts. He made a vigorous attempt in 1863, but failed for several reasons, none of which had any reference to climate. He persevered in 1864, and succeeded in obtaining 8½ maunds of cocoons, or nearly 700 lbs. At the same time other parties had been similarly successful, Mr. Scarlett's silk company at Peshawur obtained 1,200 lbs. of cocoons; other parties in various parts of the Punjab, including the military stations at Gogama and Shahpere, succeeded in rearing silkworms, and the result was most encouraging. These experiments were subsequently carried on, and efforts were made to extend sericulture to other localities, with fair promise of ultimate success. Mulberry trees were sent out in 1865 from Lyons, at the request of Dr. Forbes Watson.

For more than thirty years Mr. J. Bashford, of Surdah, Bengal, has devoted his attention to the reeling of silk, and so successful have his efforts been in improving the quality, that the Society of Arts accorded him their medal. Although superior to much of the China reeled, yet it falls far behind the finest qualities of French or Italian silk. Animated with the desire of improving the cocoons in a country so abundantly furnished with mulberry trees and every facility for breeding silk worms, Mr. Bashford introduced a quantity of the best eggs from France, Italy, and China, to cross with the poor races of Bengal, which breed all the year round. He did not desire to introduce an annual species, because that seemed destined by nature for cold climates, where the mulberry trees yield only one crop of leaves in the year, whilst in India the best trees shoot vigorously after pruning, and give, in five or six weeks, an abundant yield of fresh leaves. Although he has not yet had very great success in his experiments, he perseveres. The natives are, unfortunately, in the habit of stinting the worms in their food, and allowancing the leaves in such a manner as to injure the cocoons. Quantity of produce with them suffices; they give little attention to quality. The eggs are not sold in India as in Europe, but cocoons are bought for breeding from. Good and bad are purchased alike; no choice is made, and they are not rich enough to lose any; this is their reasoning. The houses in Bengal where the worms are raised have walls of earth or of matting, with thatched roofs. They are usually very small, and, notwithstanding the excessive heat, have neither windows, ventilators, nor anything to give light, except a fine grating, which answers for a door. They pay no attention to light or temperature, and there is one good reason for this, without the protection of trellis work the flies would enter and destroy the worms in two or three days; and, even with this protection, they do occasionally enter by millions, every year, and penetrate into the chamber at the hour when the worms are fed. More than one collection of cocoons, which looked excellent at night, has been found destroyed in the morning by the worms escaping. In the times of extreme cold there may occasionally be seen a fire at the door of the houses, but very rarely; and it is doubtful if even this is useful in buildings so badly ventilated. The variations of temperature are very considerable in Bengal during the year, and even in the 24 hours. It is frequently 20 degrees all at once. There is no effort made to equalize the temperature in these houses filled with worms, without the necessary air and giving out a pernicious odour.

Messrs. Durant and Company, in their annual Silk Circular, give the statistics for a long series of years, from which I deduce the following figures as the progressive imports of Bengal silk in bales into the United Kingdom:—

	Bales.	Prices.									
		Common.					Superior.				
		s.	d.		s.	d.	s.	d.		s.	d.
1830	8,726	10	0	to	12	0	14	0	to	16	0
1840	7,644	13	0	„	16	0	18	0	„	21	0
1850	10,090	6	0	„	10	6	12	0	„	15	0
1860	9,231	11	0	„	15	0	16	0	„	26	6
1868	6,200	13	0	„	16	0	23	0	„	31	6

In the words of a recent writer, Mr. P. R. Cola, in his essay, "How to Develop Productive Industry in India," "It may be conceded that the production of raw silk is an important branch of industry open for future skill and exertions in many parts of India, and the duty of the English Government is to go on encouraging it by every possible means, as they are doing in France."

The decennial progress of our total imports of raw silk into the United Kingdom is shown by the following figures:—

	lbs.
1821	2,641,866
1831	4,621,874
1841	4,966,098
1851	6,597,178
1861	8,835,255
1862	10,434,350

Since then the total has dropped three or four million pounds. The imports in 1868 from the East, including China and Japan, were but 5,300,000 lbs.

Indian silk is classed into two bunds—namely, the rainy and the dry weather bunds; the name being derived from the season in which it is obtained. The inferior qualities of silk are generally used by local manufacturers; the better qualities are almost wholly shipped to Europe. This most valuable product is capable of great extension and improvement. If its production were more carefully attended to, it might rival the finest silks of Italy. There is no doubt that, with continued attention, the Punjaub will soon rival Bengal in the production of this important staple. The raw silks from Burmah, and some from Assam, are of a peculiar coarseness, yet the length and strength of the thread are such as to render this silk peculiarly adapted for the manufacturing of fringes. Experiments made in France with this silk will no doubt lead in a short time to the exportation of large quantities to Europe.

The worms, being badly fed, bred in quantities, in ill-ventilated houses, with little care bestowed on them, it can scarcely be expected that good cocoons would be obtained. There are, however, a few intelligent and careful breeders, who obtain improved results, and 15 lb. of their cocoons, or about 9,500 in number, will yield one pound of very good reeled silk.

The native breeders are generally very poor, and few raise more than 100 lbs of cocoons each. Many produce far less, and often they exceed their means and starve their worms to arrive at this result. The production rests entirely with the natives, and the purchase of cocoons for winding is made by agents from house to house.

All the worms which produce silk in Bengal yield several crops of cocoons during the year, except one, an annual species, of unknown origin, and which is dying out fast.

The principal kind, known under the name of Dessie, or Dasee, signifying "Country," worm, is assumed to be an indigenous species. This furnishes nearly all the cocoons of the principal harvest of November, or that of the cold season, in Bengal, and yields the best silk. The cocoons are, however, small. In some districts the produce of the best quality is estimated at about 10,500 cocoons to one pound of silk. The worm succeeds best in the cold season, and the cocoons are better than those of the succeeding gathering, but they continue, more or less, in different localities during all the year. The interval between the hatching of the egg and the formation of the cocoon is about 36 days in the cold season, but the time sensibly decreases as the heat increases.

The next species in order of importance is the Madrassee, and, as this name signifies, "Brought from the sea," it may be concluded it is an imported species. It is very hardy, and is easily raised. The produce is comparatively better than that of the Dessie worm, since it takes only about 10,000 good cocoons for the pound of silk. The fibre is, however, less strong and brilliant, but it produces a very fine thread if wound with care. This worm passes so rapidly through its several stages, that twenty-five days suffice from the hatching of the egg to the full development of the cocoon. It will thus be seen that there are two different species of worm, suited by the wisdom of Providence to the different seasons.

The large worm known as Boroo Poloo is annual, and of unknown origin, for it existed when the East India Company sent out Italian eggs, all of which latter failed. It is principally met with now in the District of Radnagore. The silk it yields is excellent, and double that from the other kinds of India worms. But after frequent failures in the crop, irregular hatchings, and very expensive cost in breeding, besides being an annual worm, the natives have taken an aversion to it, and it is likely soon to be as rare at Radnagore as it is now in other districts.

We have seen that it takes at least 10,000 of the best Indian cocoons to produce a pound of silk, while in France about 2,500 will produce the same quantity. This great disproportion between the yield of Bengal cocoons and those of Europe must necessarily arrest attention, and the idea which naturally presents itself is that if India could produce cocoons equal to those of France and Italy the quantity of worms at present raised might supply the silk required by all Europe.

I may now summarize the principal silk-producing moths of India, and this I can well abridge from an able paper by Mr. Frederick Moon, of the India Museum, published a few years ago in my scientific journal *The Technologist.*

The common mulberry silkworm (*B. mori*), doubtless introduced from the northern provinces of China, produces only one crop annually, but spins the largest cocoon and the best silk, of a pale yellow.

There is another species (*B. sinensis*), the small Chinese monthly worm, introduced into Bengal about thirty or forty years ago, but now fast disappearing, being very delicate.

The Madrassee, or Nistry worm (*B. crœsi*) yields in Bengal and China nine crops of a good gold and yellow silk. Introduced into India about 1780, it is degenerating by reason of carelessness and improper management of the worms. Cocoons monthly between November and June, if attention be paid, but more generally from January to May.

The dasee, or country worm (*B. fortunatus*), yields a gold or yellow silk, and produces several crops annually—stated to cocoon five times in the year, at periods from 40 to 110 days.

The Arracan silkworm (*B. arracensis*) yields annually several crops of silk, superior to that produced in Bengal.

The boroo poloo (*B. textor*) produces a pure white cocoon—spun in March and April. The life of the worm is from 42 to 50 days, and the cocoon lasts from 10 to 15 days.

A wild mountain species (*B. Huttoni*), found abundantly feeding on the indigenous mulberry in the forests of the N. W. Himalaya, produces decidedly good silk, and in considerable quantities, which would be valuable. The worm, however, has hitherto proved so intractable that it cannot be reared in the ordinary way in the house, and thrives only upon the trees in the open air.

The caterpillar of *Actias selene* feeds on many wild plants, and can be easily domesticated. The cocoons in Pondicherry are softened in a solution of wood ashes, taken out, picked, and immediately spun, without being either combed or carded, the silk being exceedingly strong, tenacious, elastic, and brilliant. Four broods can be produced annually.

The Tussah (*Antheræa* [*Paphia*) is one of the most common in use of the native wild silkworms. It is found in abundance over Bengal and the adjacent provinces, and has afforded to the natives from time immemorial an abundant supply of a most durable silk. Millions of the cocoons are annually collected in the forests and taken to the silk filatures near Calcutta, but the principal place of manufacture is at Bhagulpore. Tusser silk is everywhere used as clothing by the natives, and even by Europeans, while considerable quantities of woven Tusser are imported into England.

The silk of the *B. Mylitti* and *B. Pernyi*, which is known in India under the name of Tussar silk, has been thrown with some success in England. In the Indian Department of the London Exhibition of 1862, some goods manufactured from this silk were shown, which were very fine in texture, but being woven from the raw material they do not take the dye well, and hence cannot compare with the silk of the *Bombyx Mori.*

Tusser moths are hatched twice in the year, in May and August. The larvæ go into the chrysalis state in September, remaining so till the May following; whilst those that enter the chrysalis state in July, come out in three weeks. Many of the females lay eggs in eight or ten hours after quitting the chrysalis; others, again, do not until the following night, or longer. In ten days the young larvæ make their appearance, and feed on the Asseen and Saul trees. In about three weeks from the time of the exclusion from the egg they attain their full size, and in eight or ten days more prepare for their transformation into the chrysalis. The caterpillar commences its operations by drawing a few leaves slightly together, as if to screen it from observation. It then spins a strong cord, composed of many threads, altogether about the thickness of a crow-quill, at the end of which it weaves the cocoon. This is so transparent for the first six-and-thirty hours, that the larvæ may be distinctly perceived at work in the interior. After that time, the cocoon gradually acquires consistence by the continued industry of the caterpillar, and becomes quite opaque, from the addition of a glutinous liquid with which it moistens the whole. When that dries, the cocoon appears as if covered with white powder, and in the course of a couple of days becomes perfectly hard. The moth generally deposits its eggs within a few yards of the cocoon; these the villagers collect and keep in their houses till the young caterpillars come forth, when they are placed on the Asseen trees in the jungles, the proprietors remaining to protect them from the birds, and to bring home the cocoons when perfect. The people who rear these silkworms are of the Sontal and Bhouree castes, and practise many superstitious ceremonies while tending them in the jungles.

From the experiments of M. Perottet of Pondicherry, it would appear that the statement that this moth cannot be domesticated is fabulous, as he succeeded in inducing it to breed in a state of captivity, and obtained sound and productive eggs. He managed, during a year of abundant rain, and when there was a continued damp atmosphere, to obtain four generations of these worms during the year. M. Perottet forwarded to France living cocoons of this species, and several generations were reared there, being fed on the leaves of the common oak, which were greedily eaten by them. During the early part of 1859 he sent five different despatches of living cocoons of this worm to France, which arrived safely and were doing well.

The cocoons found upon the *Terminalia* are always considered stoutest and strongest, while those on the Jujube are the weakest. Fifty cocoons obtained from the former tree will weigh one French pound. These cocoons are exceedingly rich in silk; they reel by means of an alkali or any other solvent with great facility, and to the very end. The silk they produce is very elastic and of singular brilliancy, but dark in colour.

There has been some discussion as to the distribution of this species of moth in India; the difficulties having arisen mainly from the existence of allied species in Darjeeling and other remote localities.

Dr. Roxburgh, in the 7th vol. of the Linnean Transactions, has described the preparation of the Tussah silk; and Colonel Sykes, in the 3rd vol. of the "Transactions Royal Asiatic Society," has a paper on the cocoons of the *Saturnia Paphia.*

Tussah silk could be obtained in large quantities in the wild tract of country to the eastward of the Godavery river. The breeding worms in the cocoons are there preserved in the houses. At the proper season, the young caterpillars are taken to the jungle and placed on wild trees, where in time the cocoons are formed. Demand would encourage supply to an unlimited extent. If this coarse kind of silk would sell in Europe, the whole jungle would unfold its treasure, and a very large quantity might be brought into the market annually.

The Tussah cocoons brought from Cuttack vary much in size and colour, and there is also a very perceptible diversity in the texture and glossiness of the raw silk, which, most probably, depends on the species of tree on which the caterpillar may happen to have fed. The same variety is observable in the female moths, which are of three or four different sizes and colours. The mode of winding off the thread does not differ from that pursued in the case of the ordinary silk worm proper. The Tussah silk worm feeds indiscriminately on the teak, the jujube, the mulberry, and other trees. In some places it is an annual only, but in Bengal it has at least three broods in the year.

The Moonga silk worm (*A. Assama*), feeds also upon several wild trees; it is often cultivated by the natives, and can be reared in houses, but is fed and thrives best in the open air and upon the trees. There are five broods in the year. The silk forms one of the principal exports of Assam, and leaves the country generally in the shape of thread.

The Mezankooree, a closely allied worm (*A. Mezankooree*) feeds on a species of *Tetranthera* in Assam. The silk is nearly white, its value being fifty per cent. above that of the Moonga, and it constitutes the dress of the higher classes in Assam. The oak-feeding silk worm of North West India (*A. Roylei*), feeds on the common hill oak (*Quercus incana*). The cocoon is large and very tough, and the silk is pronounced as promising, and worth cultivation. An allied species (*A. Pernyii*), has been introduced into France from China.

The Atlas moth (*Attacus Atlia*) the caterpillar of which feeds on the leaves of *Falconeria insignis, Bradleia ovata,* &c., is stated to produce the Tussah silk of China. It is easily reared in a state of domestication, producing a cocoon well stored with a fine yet strong silk, of a greyish colour.

The *Attacus Canningii* is the wild sub-Himalayan Eria silkworm, feeding on *Coriana nepalensis, Xanthophyllum hostile, and Ricinus communis.*

Attacus ricini is the commonly cultivated Eria or Arindy silkworm, which, in Bengal, yields four or five crops annually, and is reared over a great part of Hindostan, in houses in a domestic state, feeding on the leaves of the castor-oil plant. It gives a cloth of seemingly loose texture, but of incredible durability, the life of one person, it is stated, being seldom sufficient to wear out a garment made of it. The thread is woven like cotton, and the clothes are mostly used for home consumption by the poorer classes at all seasons, and by the highest for winter wear.

These wild silkworms may be thought by many unworthy of notice, as they do not yield that kind of silk most valued in commerce, but they are more important than they at first appear to be. We must remember that the culture of some in the forests, and the collection of all, affords employment to considerable numbers of the natives in the parts of districts least productive of useful occupation. They afford also clothing for many of the inhabitants. In one district alone, *that of Azimghur,* it was stated that, in 1837, 318,772 pieces of Tussah silk were turned out annually from the looms.

The inquiry as to which is the tree best adapted in India or elsewhere for the production of good silk, although apparently a very simple one, is in reality not easily answered, since much must depend upon the species of worm under cultivation, as well as upon the climate itself; and the difficulty is enhanced by the fact that every one who, possessed of much zeal but little knowledge of the subject, essays to rear silkworms, appears to think it necessary to extol some particular species of mulberry, and to pronounce it for the time the *ne plus ultra* of silkworm diet. One while it is the white-fruited mulberry only that can enable the insect to elaborate good silk; and anon, for some inexplicable whim, the white is discarded, and another tree adopted in its stead. The purple-fruited species is unhesitatingly denounced. And yet the white mulberry is found to be nothing more than an albino variety of the purple-fruited tree.

In the report of the Agri-Horticultural Society of Calcutta, for 1866, notice is taken of the experiments in various parts of Bengal with the varieties of the Japan silkworm, which are stated to yield a much superior silk to the monthly worm of Bengal, and samples raised from this stock at Ghotal were considered by Mr. Turnbull as infinitely superior to the general run of Radnagore silk, and not far short of Italian. In consequence of this favourable result further supplies of eggs were ordered, and the experiments continued.

The cultivation of the silkworm in Oude was believed to be capable of great extension, as the mulberry abounds throughout the province, and the climate appeared to be favourable to the rearing and thriving of the worms. Of silk from Oude shown at the London Exhibition in 1862, Messrs. Durant reported that it was, in some respects better than the silk of Bengal, inasmuch as it had more nerve and less of the fluffiness which, more or less, seems to be an inherent condition of even the best of the European filatures of that country.

In 1861 Dr. Bonavia commenced the cultivation of various kinds of mulberry trees in Lucknow, distributing cuttings to the officers of all the districts in Oude, and energetically induced the natives to rear silkworms. After repeated trials, he stated in 1865 that his experiments were given up, for it was found that *multivoltine* varieties required more care than any native would be inclined to give them, in a climate like that of Oude, where the contrasts of temperature between different seasons are so great. The *Univoltine,* or annual variety, also, did not succeed sufficiently well to give much encouragement. He further states, that if silkworm breeding is ever to succeed in Oude, it must be some hardy annual variety, feeding on the hardy native mulberry.

The cocoons of Oude and Umritsur are said to have degenerated in one season 56 per cent. below the Cashmere standard. Cocoons raised at Lucknow, in Oude, by Dr. Bonavia required 5,200 to the pound of silk. At Candahar, in 1849, the Afghans reckoned about 4,500 to the pound of silk, while in France, previous to the late epidemic, 2,500 cocoons were, on the testimony of Mr. Bashford, equal to a pound of silk. Here, then, we have positive evidence that the climate of the Punjab and other parts of the plains of India is injurious to the health and general well-being of the insect.

The political resident at Munnipore, writing in 1864, states that there can be no doubt of the suitability of the climate of the locality to the growth of the finest quality of silk.

With the sanction of government, an experiment was instituted by Captain Thomas Hutton, at Mussooree, in the N.W. Himalayas, in 1850, having for its object the eventual cultivation of the wild Himalayan silkworm, known as *Bombyx Huttoni*, and for this purpose he was instructed to form a plantation of the indigenous mulberry trees, three years being granted in which to finish the work. Subsequent trials proved unfavourable to the chance of future success with this species. Captain Hutton, however, represents that experiments tried with the domesticated *Cashmere* and Bengal *Madrassee* worms, had proved, beyond a doubt, not only that these worms throve well in the climate of Mussooree, but that there was also a ready and remunerative market for the silk.

Is it not (asks Captain Hutton) a well-understood and long-established fact, that, whether among animals or plants, an occasional renewal of seed, and reinfusion of the original stamina is found to be absolutely necessary for the preservation of health and of that particular standard of perfection which it is thought desirable to maintain? And yet, with the domesticated *Bombyx mori*, this necessary precaution has been uniformly neglected for 400 or 500 years. What wonder, then, that under the combined effects of bad and scanty food, want of sufficient light and ventilation, too high a temperature, and with the constant and unvarying interbreeding of a debilitated stock, the insect should have become subject to a multitude of maladies, and threaten, at no distant period, to become extinct.

As early as the year 1791, experiments for the introduction and culture of what succeeded so well in Bengal, were made in the Presidency of Madras, and continued for several years, but without any permanent results; as in the year 1854 only 1666 lbs. of silk were exported. This is probably owing to the climate of the Madras Presidency being generally unsuited to the culture; for, in the more elevated climate of Mysore experiments have been continued to the present time, and some very good specimens of silk were sent to the Exhibitions both of 1851 and 1855; also to the Exhibition held at Madras in 1857; when it was stated as probable that the culture might be successfully carried on in the valleys of Neilgherries. The silk produced in Mysore is required for the manufacture of the silk shawls of that province.

In the same way, experiments were made in the Bombay Presidency about the year 1755, repeated again in the Deccan in the year 1830, and persevered in for ten years, under the superintendence of an Italian, M. Mutti, but without eventual success, as was always anticipated by Dr. Gibson, in consequence of the heat and dryness of the climate.

Though these instances may appear to put limits to the extension of silk culture in India, and to a supply of raw material from that country; they only do so in the districts having the climate which has been indicated. In the valley along the foot of the Himalayas, in North Western India, there is a less arid soil, a more temperate climate, and species of mulberry appear indigenous and flourishing. This is still more the case in the lower hills which bound the Punjab and in many parts of the Punjab itself. Here, indeed, a most successful experiment has been commenced, of which the results were shown in the Paris Exhibition of 1855.

Experiments were for some time energetically carried on by the late Mr. Cassamajor and by Major Minchin. Silk from Italian worms was successfully reared at Katy, and silk was produced of good quality on the estate of Mr. F. Lascelles on the Neilgherry hills. Quantities of silk may be looked for yet from these localities, from Assam, Bokhara, and Affghanistan, whilst the dry and equable climate of Scinde is especially favourable to silk culture.

The cultivation of the mulberry in connexion with the manufacture of silk has been carried on for many years in the talooks lying in the vicinity of Bangalore, Mysore, and Seringapatam, where are chiefly congregated the Mussulman communities, to whom this branch of industry is almost wholly confined. Devoid of energy, and unaided by the capital which could enable them to import varieties, both of the mulberry and the silkworm, they have been content to eke out a bare subsistence, and, indeed, from the rapid deterioration which has been going on in both respects the local trade had been for some years in a languishing state. The settlement, however, of a Silk Filature Company, conducted by an Italian gentleman at Kengari, near Bangalore, and the introduction of new breeds of silkworms, as well as of improved kinds of mulberry, promise to inaugurate a new era in the silk manufactures of Mysore. The increased demand thus occasioned has given a stimulus to the production of a better kind of silk, and, in order further to promote this object, arrangements were made, in 1865, with Signor de Vecchi for the importation of silkworm eggs from Japan, for distribution to those who were willing to rear them with care and to give the experiment a fair trial. The only kind of silkworm hitherto reared in the Mysore country is the China variety. These worms yield cocoons which are described as being much inferior to those of China and Japan; the silk is not closely woven, and is internally flossy, though the quality of the thread, when reeled by European processes, is found to be good. The inferior quality of the native reeled silk is evidenced by the value. The best samples, which are worth on the spot 4 or 5 rupees (8s. or 10s.) a seer (equal to three-fifths of a lb.), would not in Europe obtain a higher price than 13 or 14 shillings per lb.

Some singular religious notions stand in the way of the extended production of silk by the natives of the East. Thus Mr. Wright, of Peradenia, near Kandy, Ceylon, after making exertions to extend the culture of the silkworm, and forwarding 500 or 600 cocoons to be distribute among the natives, called the headmen to assist, but they doubted whether the priests of Buddha would sanction the cultivation of the silkworm. The high priests were convened, and came to the meeting in their large yellow silk shirts—their sacerdotal dress; but nothing could induce them to recommend an occupation which involve the destruction of life. "Why," said the agent, "you come here, wrapped in the spoils of the worms that are killed by the strictest Buddhists in China and Siam." But they would not sanction a practice which involved the destruction of the worm, although they themselves gave the greatest encouragement to it by the use of silk.

Silkworms are common in many parts of the province of Burmah. In the district of Sandoway, the eggs are hatched by the ordinary heat of the weather all throughout the year, and a supply thus kept up, but the silk procured not being good at all times, it is not until December that the silk for sale is obtained. In that month the worm is largely bred, and the cocoons are formed in February. No selection is made of the best silk, but it is sold indiscriminately, and used in the district in the manufacture of native dresses. Silkworms are also extensively used in the northern and western parts of Toungoo. Attempts have been made to introduce a better breed of worms, by importing eggs from Moorshedabad in Bengal.

I have now somewhat hastily skimmed over the subject of silk production in India. Imperfectly as this has been done, I trust it will open up a field of inquiry and discussion which may result in benefit hereafter to that great and important dependency of the British Empire, as well as in supplying the urgent wants of the factories of Europe. The Society of Arts has long devoted its best energies to this subject, and it is to be hoped that this appeal, made for further detailed information, and for useful suggestions as to the best mode of stimulating the production and improving the quality of Indian silk, may not have been made in vain.

DISCUSSION.

Mr. Thomas Dickins, Chairman of the Silk Supply Association, believed the statement Mr. Simmonds had made was on the whole very correct with reference to India; but the unfortunate fact still remained that the quality of the silk produced there was very defective, and would continue to be so, so long as the present mode of reeling the silk was carried on. The great cost in the production of silk was already experienced when the cocoon was produced. The silk worm required so much food and so much attention, and the great object sought was to get the largest quantity of silk from the smallest number of worms. In France, in Italy, and the best silk-producing countries, about 12 lbs. of the green cocoons—that was French cocoons—were sufficient to yield 1 lb. of silk. That 12 lbs. when dried and pressed for packing for exportation, lost about 75 per cent., and when the cocoons were imported in that state from Asia Minor, and such places as now exported cocoons, about 4 lbs. was sufficient to produce 1 lb. of silk. In India and China, wherever the silk was imperfectly reeled, they required twice or three times that quantity; and, therefore, it would be evident that the great cost of producing silk was in that proportion twice or three times enhanced up to the point of reeling the cocoons, so that if in India we could have a better and stronger worm, such as was produced in France and Italy from the Japanese seed, that would be one great point gained. Then, again, the misfortune and great error in the production of silk in all countries except France and Italy, was the practice of reeling the silk there instead of sending the cocoons to Europe, where the machinery and the whole system of reeling was carried out to much greater perfection. The filament of all these countries probably was of about the same quality; whether Bengal, China, Japan, or France, the filament was about the same; and if in reeling the same number of filaments were continued throughout the thread, then the Bengal and Chinese thread would be quite equal to the Italian or French thread; but the superior mode of reeling in Europe enabled the weavers to continue the thread of four or five filaments throughout, and made the silk worth 45s. per lb.; whereas, from the defective reeling in India, the thread varied from four up to twenty-five or thirty filaments, and owing to its uneven character was worth only a third or a fourth of that sum, whilst the cocoons were just the same in both instances. Therefore, he suggested that all parties interested in this question, more particularly with regard to India, should give every possible encouragement to the proper desiccation of the cocoons, press-packing them, and sending them to the best market, such as Marseilles, where they might be reeled. The time might come when we might import the raw material into this country and reel it here. Marseilles presented the great market for this country, and he believed the cocoons if so imported, press-packed, would realise to the merchants who imported them a far greater value than silk reeled in the defective state in which it was now received from India and elsewhere. He purposed at the end of next month reading a paper on silk supply before the Society, in which he should be prepared to enter more fully into the subject by referring to all the countries capable of producing silk, and the comparative qualities which those countries produced at the present time.

Dr. Archibald Campbell (late Superintendent of Darjeeling) attached great importance to the suggestion of Mr. Dickins that encouragement should be given to the sending of the cocoons to be reeled in Europe. It was very desirable that we should ascertain the causes of the falling off in the quantity of the silk from India as well as to direct attention to the means of improving the quality of the article produced. In this respect he thought they should receive active assistance from the Government. He thought it could be done by application to the Governor-General to appoint an officer—say for one year—a man of capacity and information, who had a desire to increase the supply, to make a tour of the principal silk-producing provinces of the Punjaub and Bengal, and to report upon the actual state of the production now as compared with other countries; also as to the causes of failure, and what could be suggested to remove those causes of failure. With regard to the wild kinds of silk mentioned, he believed, if it could be made suitable for our requirements, it could be produced to an unlimited extent, inasmuch as the worms fed upon the castor oil plant, which grew abundantly without cultivation, and only required to be defended from animals. Besides affording food for the silkworms, considerable quantities of oil were obtained by the natives from the seeds of the plant. He repeated, if the article could be made suitable for European requirements, the silk might be produced to an unlimited extent.

Major-General Sir William Denison (late Governor of Madras) thought all these propositions which called upon the government to step in to aid and assist in these sort of matters which really concerned the public at large were futile. He told them frankly, government had not the power to deal with this question, which appeared to him to lie entirely in the hands of those who were officially interested in the matter. For instance, they were told "Here are the cocoons, some large and some small; but if they were broken and pressed and brought home to Marseilles to be reeled, one cocoon is just as good as another." It appeared from what Mr. Dickens said, there was no difference in the quality of the filaments, the filament of one cocoon being just as good as another, and that if the cocoons were imported into Marseilles and wound off there by proper mechanical means, the silk of India would be just as good as that of any other country. The simple process, therefore, was for those interested in the matter to purchase the cocoons from the growers in India and send them to Europe to be reeled for the market. But our habit, he was bound to say, was too much to call upon Jupiter to help us instead of helping ourselves—to call upon government to do that which no government was able to do. Government might appoint such officers as Dr. Campbell had suggested, and might give advice; but in the first place they could not be certain that the officer appointed was a properly qualified one, who understood the work, and had an interest in doing it; because that was the main thing. They might pay a man so many rupees per month to travel about, but they could not guarantee that the work would be worth anything when it was done; but give a man an interest in whatever it might be, whether cotton or silk or any other production, they would then have some chance of getting a fair result. He spoke from personal experience. He had these things thrust upon him when he was in Madras. The Cotton Supply Association went to the government, and the government pressed upon him to do this and that. But when the Cotton Association sent out their people, instead of asking his advice, they wanted to work out their own system in their own way, by his help, or in other words, with the funds which the government had at its disposal—a pleasant way perhaps of doing things, but it was not the way to succeed. They must put their own shoulders to the wheel, and the persons interested in this undertaking must look to themselves and not through the eyes of others, or try to interest others in doing the work they ought to do for themselves. His experience in India extended only over 5 or 6 years, but he inquired into the character of the natives, and they would find it remarkably difficult to change a habit which had been working in these people century upon century. Lord Tweeddale, his predecessor in Madras, tried to introduce European improvements. He endeavoured to show the people that by using the Scotch plough, and ploughing deep, they would produce double the crops they were then producing; but what did the people say? "Yes, you English are wonderful people, but our grandfathers did as we do, and we do not see why we should not do exactly the same," and they did it. What they wanted was to teach the natives—and that would be a slow process—the principles on which these matters were founded, and to teach them to apply the materials they have upon something like principle. Iron was an article which had to be imported, and there was scarcely such a thing as a blacksmith to be found. There was a want of mechanical ingenuity, a want of mechanical application, and that was what they must teach the natives first. With regard to silk, if they required it to be properly wound, they must get people to do it. As to teaching the natives to do it, it was perfectly hopeless. They required to get the idea into their head first, and then the idea must be developed by practice.

Mr. **Hyde Clarke** said, after the discouraging speech of Sir W. Denison, who had resided in India, perhaps he might be in a better position to say something upon a question often mooted amongst Indians and statesmen in this country, having had much the same experience as Sir W. Denison, and not having arrived at the same conclusions. Having acted for a considerable period as the Commissioner of the Ottoman government in Turkey, he (Mr. Clarke) had opportunities of seeing the working of some of the questions to which Sir W. Denison had referred. To those who had any knowledge of the East, nothing could be more practical than the observations of Sir W. Denison as to the difficulty of introducing European improvements amongst the natives of the East. It was necessary that anything introduced should be adapted to the purposes of the population. They had seen such failures as Sir W. Denison had described; but he was sure they must all have seen how, when an improvement had been properly introduced, it had been successfully carried out. Indeed, to say—as he understood Sir W. Denison's statement to amount to—that improvements could not be effected in India, was tantamount to saying that no improvements had been effected there, and that we ought to give up all efforts for the improvement of India, in defiance of the experience of the past and of the progress of the present. Sir W. Denison had told them that those interested in the cultivation of silk ought not to apply to government for assistance—not to call upon Jupiter to help them—but that the manufacturers of Manchester and Macclesfield ought to do these things for themselves. Did the statesmen in India who agreed with Sir W. Denison wish to place the English government of India in a less favourable light than the Turkish government of Turkey? That was a question worth asking, and it was an inducement for him to endeavour to answer one who had occupied a high position as a governor and statesman not only in India but in other parts of the world. He would say when the Cotton Supply Association applied to the government of Turkey, they met with instantaneous response and co-operation. They knew, on the other hand, that when they applied to the government of India, it was with difficulty they had obtained assistance from men who, having the interests of England at heart, and those of India likewise, would otherwise have been inclined to have given assistance, which had only been tardily and grudgingly afforded. Why had that been? Not so much he believed from the want of disposition as from an unfortunate theory of political economy; because, whether with regard to India or England, we ought to be particularly careful not to confound political economy with politics. Political economy was not the science of development; and though it was desirable as a principle that government should not interfere, and that trade should look after itself, yet that ceased to be a sound principle of politics when applied to a country like India or a country like Turkey. Any one who was acquainted with the governments of the East, knew how much the condition of a large population might be influenced by one man. Notwithstanding the discouraging account of Sir W. Denison, he (Mr. Clarke) had heard that during the period he held the governorship of Madras, he was able to do a great deal for the improvement and benefit of that population. He said we ought not to be led away by simple axioms of political economy on a subject like this, but we must take a common-sense view of the matter; and he thought the statesmen of India, who held the opinion that the government ought not to listen to the applications of the Cotton Association or the Silk Association for assistance, were taking a false ground when they said the government was not the party to apply to. Without going into the theory of the question he would refer to his own experience. He stated that the government of Turkey readily granted the assistance which was asked for. What was the result? The government of Turkey received a large addition to its revenues in consequence of the co-operation it afforded. Assuredly the government of India had obtained benefits from the promotion of cotton cultivation or anything else for the improvement of the country; and if they gave assistance with regard to the cultivation of silk or anything calculated to benefit India or the manufacturers of England in relation to Indian products, we might be assured that the government would participate in the benefits obtained. If that were the case why should we go back to remote principles of political economy, and say that the merchants of Manchester and the manufacturers of Macclesfield should do all this work with regard to cotton and silk; that they should ask for no co-operation, but that the government should receive the benefit of anything that came in their way. Was that a fair way of putting a question of this kind? It placed the government of India in a false position as between the community in England and in India. If we looked at the subject practically with reference to the population of India, he said, without having had experience in India itself, but having some experience of Eastern countries—if the government did its duty in this matter of silk supply, it would not obtain the discouraging results prophesied, but would obtain great benefit for itself and vast advantages for the community of India; and it was only by the co-operation of the government that these results could be obtained. It was impossible for manufacturers interested in this question to carry out, in a distant country like India, what was required in this case. And there was another circumstance, India was not the sole silk-producing country; and if the government of India would not do what other governments interested were doing, or would do, India would be thrown behind and would not reap those advantages which its natural position and its vast population would enable it otherwise to obtain. He would make no more remarks upon this part of the subject, because there were those present connected with India who would, no doubt, take it up. He thought all would concur in the propriety of Dr. Campbell's suggestion of the appointment of such an officer as he had designated, and under the conditions mentioned by Sir W. Denison, that he should be a man thoroughly qualified for the purpose. He (Mr. Clarke) believed if such an officer were appointed in India, it would be the means of doing as much for the promotion of silk cultivation, as in the case of those appointed for the purpose of assisting cotton cultivation. He knew the government of India had done a great deal for cotton cultivation, and it was by extension in the same way with regard to that and other products that a great deal more was to be done. He would, in conclusion, say a word with regard to the employment of the Mussulman population in this branch of industry. He saw that in connection with the silk products of Turkey, the Mussulman population, as they knew, always endeavoured to keep up a standard of respectability. Women of the better class were not employed in outdoor work, or in menial pursuits, and it was only by household work that they obtained the means of existence if left without means, in a state of widowhood. Under these circumstances the cultivation of the silkworm was found to be a respectable means of maintaining the family, and in that way the cultivation of silk had been found beneficial amongst the Mussulman population of Turkey. In the filatures introduced into Turkey, chiefly by the French, and which had contributed to the improvement of the silk of that country, the Turkish women were employed, not only in the establishments of Mussulman proprietors, but also in those of French and other European proprietors. It was considered no social degradation to be so employed, though the poorer orders generally engaged in that pursuit. Of course no one expected that a population would change its habits all at once, but if any pursuit could be introduced under favourable and judicious auspices, he thought they might look forward to great results. So far as he could judge from his experience in another country, he thought the prospects of action in this direction in India were so far favourable. Still they might meet in some districts with the obstacles that had been pointed out, which might impede the movement. On the other hand they would find other districts better disposed where the could make more progress. With regard to the question raised by Mr. Dickins as to the reeling of the silk in India or Marseilles, it was an important English trade question with regard to the silk market itself. At one period we had much greater command over the silk market than we have at present. The French had become great rivals, and if, under the encouragement sought for, the production of silk in India was increased, and it was sent to Marseilles, it would be a great discouragement to our own market, and make Lyons a still greater silk market than it is now. Under these circumstances it was a matter of importance for the government and the friends of India to do what they could to promote the proper reeling of silk in India, of which successful examples had been brought before them this evening, and which had also taken place in Turkey. If they obtained better reeling in India then the silk would be brought direct to the London market, and they would be able to improve and promote the market here. He must say, in conclusion, that the presence of the Chairman on that occasion was a protest, as it were—he did not say against the doctrine of Sir William Denison, because he was one of a large party in England—but against that gentleman's vindication of the conduct of the government. From what cause did the chairman hold his present position? Because, on account of his attainments and the great attention he has given to the subject of Indian products, it was felt he could promote the views of the government in enabling India to contribute more largely to our manufacturing requirements. It was by such action that the government best did its duty by encouraging the merchants and manufacturers of England to do their share for the common benefit of mankind.

Colonel **Collyer**, R.E. remarked that probably the name of Dr. White was known to many present. He was a great botanist and agriculturist; and in reference to Mr. Hyde Clarke's adverse criticism upon the government in contrasting it unfavourably with the Turkish government, with reference to the assistance given by the latter to the cotton interest, he begged to state that from 1842 up to 1844 the government engaged a number of American cotton planters from New Orleans under Dr. White, and everything possible was done to improve the cotton cultivation at the expense of the government; but it was a failure, and the planters were sent back again. He thought Sir W. Denison's remarks had been misunderstood. He did not think he meant to say that if there were any difficulties in the way of growing silk in India, the government could not assist; but he understood Mr. Dickins to say that the Indian silk *per se* was as good as that of any other country, the only fault being in the manipulation of the article. He did not think it was the business of the government to teach the natives to reel the silk in a condition which the European manufacturers approved, but he thought it was rather the duty of those who were interested in it.

Mr. **Turnbull** said, although he was aware that the natives of India were a very unteachable race, and that the Bengalese were worse than anything Sir W. Denison had seen at Madras, yet they had been taught the cultivation of indigo remarkably well; he therefore could not express how astonished he was to hear it said that they could not be taught to reel silk well, because it was one of the simplest operations a person could be called upon to perform. He knew there were things which the natives of Bengal could not do well unless they were superintended by Europeans who understood the business, and could take means to make the natives understand it. He heard Sir W. Denison say there was no iron in India. That might be true, but he (Mr. Turnbull) never wanted iron in Bengal without being able to get it; and he never knew a native mechanic who, if a thing was placed before him, could not make one of the same kind. His own idea was, that the natives of India under good superintendence were a very teachable people. He had had thousands under his superintendence, and had had business relations with them of various kinds. He did not think they had had justice done to them. They were as docile and tractable as children when properly treated, and would do almost anything that was required of them.

Mr. F. **Hendriks**, though convinced of the soundness of Sir W. Denison's remarks as to self-help in respect of the Anglo-Saxon race, doubted their application to races like those in India. They looked rather to be taught than to help themselves or take the initiative. In point of fact that was the principle of success of the neighbouring nation of China, because they could teach the inhabitants of India the methods by which such industries could be performed with success. They knew that in China it was part of their religion to know how to cultivate the silkworm, and the theory and practice of it were laid down in the sacred books in which they were examined. He thought the government of India was paternal rather than representative; he thought the time had arrived when this and other societies who had discussions of this kind before them might consider whether boards of agriculture, commerce, and manufacture might not be established in India. He did not say they need be an expense to the country. It had been objected that, if officers were appointed to travel through the silk-producing provinces, they might not be sufficiently informed themselves to be able to teach the natives. Associations might be formed which would particularly take upon themselves the duty of making the natives of India well informed upon the best principles for the promotion of art-manufacture and industry. These boards might consist of natives of position and influence as well as Europeans, and he fancied the results would be found exceedingly satisfactory. He merely threw out the suggestion for the consideration of those who had had experience in India. Even in this country industry was stimulated by rewards and in other ways, and he thought a similar system applied to India would be productive of good results.

The Hon. **George Campbell** (Judge of the Supreme Court), would rather have listened to a practical discussion with regard to the cultivation of silk, but inasmuch as it had taken another turn he would say a word or two with respect to government assistance in this matter. They could not lay down any absolute rule. There were some cases in which the government might with advantage assist, and others in which government could do no good. When they introduced something entirely new, government could and ought to assist in manufacture or cultivation; but in the case of an old cultivation like silk, he doubted whether government could do so. Moreover, it appeared to him that the silk industry in India had passed beyond that stage, because they had not only the old native cultivation of silk, but the European manufacture of the article, and, as far as he was acquainted with the matter, he believed the silk of commerce was of European manufacture, and that the silk came almost exclusively from Bengal, where they had a set of men from this country, who had produced it in an admirable manner. He heard from Mr. Dickins with great astonishment that the great fault of the silk from India was in the reeling, because that was an operation exclusively conducted under European superintendence, and it was his belief that, under that superintendence, it had been brought to perfection. But if the fault was in the manufacture, the remedy did not lie with the government nor with a Society such as this. A gentleman had alluded to the cultivation of indigo which, under European superintendence, had been carried out successfully. There were difficulties in the way of that cultivation at first; but he thought silk had not suffered from any of those difficulties, and contentions between capital and labour and between planter and ryot. He knew farms which, in difficulty with respect to indigo, carried out silk cultivation with great success. Therefore, having got to that stage, it remained that, as had been asserted to-night, they were deficient in the manipulation of the article. What was required to be done was to teach the natives how to manufacture their silk more efficiently, and send it to the market in such a state as to acquire greater value. He would add his testimony to that which had already been given. He must say he thought Sir W. Denison had expressed merely his own views, when he said the natives of India were not capable of mechanical art, and he was surprised to hear a gentleman of his experience say there was hardly a native blacksmith to be found. If one class of artisan was more numerous than another it was that of the blacksmith, and in European manufactories the finest portions of the work were done exclusively by native hands. He doubted whether, if they learnt an improved system of agriculture, they would adopt it. There was deep ploughing; but, looking to the nature of the soil, the natives understood their own agriculture better than we; and so-called improvements in agriculture were not lasting, but resulted in dead loss. The natives understood their own business, and were waiting till we showed them such an improved method as would produce improved results. If we showed them that, by methods within their means, they were ready and willing to adopt the improvements.

Sir W. **Denison**, in explanation, said he did not mean to say there were no cutlers in India. What he said was, if they wanted machinery repaired of which cast-iron was a part, they could find no person capable of doing it unless they sent it to Madras. He admitted the Indian workmen were most admirable cutlers, and in various descriptions of handicraft they excelled.

Mr. **Campbell** begged to say one word further. He had little technical knowledge of silk, but would contribute his small mite of knowledge with regard to the practical question before them. One gentleman alluded to the Punjaub, and on that point he could say with confidence that government officials had done their utmost in the way of trying experiments in the cultivation of silk there; but he thought the result was rather to show that for the successful cultivation of the silkworm they wanted, first, temperate climate, and secondly, a climate in some degree moist. He had seen experiments in silk cultivation at Lucknow, and was acquainted with Dr. Bonavia, who came from a southern country. If any one was calculated to carry out the experiments successfully, that gentleman was the person to do so; but the result was failure. He (Mr. Campbell) attributed that fact to the dryness of the climate of Lucknow. The Punjaub was still drier, and the results there were discouraging; but there were other districts of India in which the prospects were more hopeful. What he would urge upon the members of this Society was, that they should try to get at the root of the matter, and ascertain the climate and conditions suitable for the silkworm, and in that way to put the matter in a practical shape, so as to induce silk cultivation in those districts of India where the climate is most assimilated to that of France and Italy, where the cultivation of silk was most successfully carried out.

Major-General **Clarke** could bear personal testimony to what had been stated by Mr. Simmonds relative to the experiments made in silk cultivation in Bengal and Oude. With respect to the latter, it might have been foreseen that they would fail, because the locality was one of the driest in India. In 1852 there was only one self supporting silk cultivating establishment in Bengal proper. He might mention, and claim what credit it was entitled to, that it occurred to him, in 1860, that the moister parts of Oude were suited for the silk-worm; he accordingly procured a supply from Cashmere, and with the assistance of a gentleman connected with a filature in Bengal, he succeeded in producing some capital cocoons, but he could not get the Bengal men to come up there. The eggs were sent up the hills to be hatched in a cool climate, and the worms were brought down in September or October. He was astonished at the success of that experiment. The cocoons were reeled, and a favourable report of the result was made. Some of the silk was sent to the Exhibition of 1862, but he had not heard that it was reported upon; it was, however, the opinion of Mr. Durant, of the firm of Durant and Co., that it was superior to the silk produced in Bengal.

Mr. J. C. **Wilson** suggested whether a middle course between the views of Mr. Hyde Clarke and those of Sir W. Denison might not be advantageously adopted. The representatives of trade appeared to desire an active sympathy and encouragement on the part of the government, who declined to devote the public funds to that purpose. Could not the trading interest conduct their own operations, with their own funds, by means of their own agents, and could not the government at the same time give its active sympathy and encouragement, and patronise the objects of commerce in every possible way, without the necessity of putting their hands into the public purse?

The **Chairman** in proposing a vote of thanks to Mr. Simmonds for his paper, said it was too late to go into all the various questions started in the discussion. Without following the remarks as to what should be the course of the government in this matter, he thought he might safely say that if any practical propositions could be laid before the government, they would be found ready to act upon them. With regard to the question of the introduction of better cocoons into India, that was a practical one which would require the attention of practical men on the spot. No doubt a great deal could be done to improve the quality of the cocoons, and he believed attention was directed to that, and the introduction of fresh seed from Japan was producing a certain amount of beneficial effect.

Mr. **George Campbell** asked what were the limits of climate within which silk could be successfully cultivated?

The **Chairman** replied that was a very difficult question to answer. Judging from experience, it would seem that a very dry, and at the same time hot, climate was not well suited for silk cultivation. Upon the whole, he thought the climate of Mysore most completely answered the conditions required for this cultivation, and that it could probably be carried on there with better results than in Bengal.

Mr. **Campbell** inquired whether they must have a cold climate; to which

The **Chairman** replied—Not necessarily.

The vote of thanks having been passed,

Mr. Simmonds expressed a hope that the remarks he had made would not be taken as an appeal on the part of the manufacturers to government for aid. They were endeavouring to aid themselves, by forming an association of their own body to promote discussion and to obtain information; and the suggestion of Dr. Campbell, based, no doubt, upon his experience in India, on which the discussion had principally turned, was quite a voluntary one. They found that other governments were now paying attention to the subject. The South American Republic and the Australian Government had instructed their agents to give all the aid in their power in diffusing information, and that was all they asked. He happened to be the hon. secretary of the Silk Supply Association. They did not wish either this Society or the officials of the government to be compromised in any way. There were various points on which the India Office and the Colonial Office were capable of furnishing information, such for instance as whether better cocoons could be introduced into India; whether the silk worm disease was spreading; what localities were best adapted for silk cultivation. On these points the government could aid them; but as to asking them to contribute funds, or do anything out of the province of political matters, that had not been thought of.

Dr. Campbell remarked that one officer employed in the way he suggested would do more in one year than could be done by other means in two. He believed there never was a time when the government was more anxious to extend the commerce of India. As in the case of cotton in Turkey, it would tend to facilitate the objects which the Silk Association had in view.

Seventeenth Ordinary Meeting.

Wednesday, April 7th, 1869; W. **Bridges Adams**, Esq., in the chair.

The following candidates were proposed for election as members of the Society:—

Alex. Ephraim, 5, Brook-street, Grosvenor-square, W.
Altmann, Henry J., 16, Caroline-street, Bedford-square, W.C.
Anderson, Francis, M.D., 47, Arundel-gardens, Kensington-park, W.
Armstead, H. H., Bridge-house, Eccleston-bridge, S.W.
Barlow, W. H., High Combe, Old Charlton.
Bath, Edward, Law Clerk's Office, Waterloo-bridge Station, S.E.
Bedford, Edwin, 5, Royal-crescent, Notting-hill, W.
Bell, George S., 110, Great Russell-street, W.C.
Benson, William, 147, Albany-street, N.W.
Brooke, George, 72, Myddelton-square, E.C.
Brooks, James, 11, Serle-street, W.C.
Berry, Thomas, 1, Halkin-street, Hyde-park-corner, S.W.
D'Orsey, Rev. Alexander, J. D., 13, Prince's-square, W.
Hichens, Captain William, Royal Engineers.
Norton, Thomas Sterry, Lestelle, Sydenham-rise, Forest-hill, S.E.
Thorne, Eliseus, the Thorns, Worcester-park. near Kingston-on-Thames.
Wigan, Frederick, Clare-lawn, East-sheen, S.W.

The following candidates were balloted for, and duly elected members of the Society:—

Backhouse, Edmund, M.P., 84, Eaton-place, S.W.
Barry, Charles, 1, Westminster-chambers, S.W.
Bourne, Lieut.-Colonel, J., M.P., Heathfield, Wavertree, Liverpool.
Briggs, General John, F.R.S., Oriental Club, W. Athenæum Club, S.W., and Bridge-lodge, Burgess-hill, Sussex.
Burke, Edmund Haviland, M.P., 13, Old-square, Lincoln's-inn, W.C.
Grosvenor, Earl, M.P., 28, Prince's-gate, W.
Knaggs, James, Helmsley-house, London-fields, Hackney N.E.
Lea, Thomas, M.P., The Larches, Kidderminster.
Mauritius, the Bishop of, St. Nicholas Rectory, Guildford.
McGarel, Mrs., 2, Belgrave-square, S.W.
Nunes, Francis, Hayes-grove, near Bromley, Kent.
Parry, T. L. D. Jones, M.P., Junior United Service Club, S.W.
Potter, Thomas Bayley, M.P., Langham Hotel, W.
Stone, William Henry, M.P., Dulwich-hill, S.E.
Tredegar, Lord, 39, Portman-square, W.
Wingfield, Sir C. J., K.S.I., M.P., 37, Clarges-street, W.

The Paper read was—

ON THE THEORY OF BOILING IN CONNEXION WITH SOME PROCESSES IN THE USEFUL ARTS.

By Charles Tomlinson, Esq., F.R.S., F.C.S.

In some of the old colliery engines of Scotland, when the steam becomes slack, and there is no time for cleaning out the boiler, the engine-men are accustomed to throw into it about a bushel of the radicles of barley, produced during the malting, and separated in cleaning the malt. The effect of these radicles (or *comings*, as the men call them) becomes immediately apparent on again raising the steam, for not only is there an abundant supply for producing the full working speed of the engine, but an excess, going to waste at the safety-valve. This singular effect will continue during several days.

Let us take another example from Scotch practice. In the distillation of ardent spirits on a large scale, it is customary, when converting the wash into what are called "low wines," to throw a lump of soap into the still every time it is charged. This has the effect not only of causing the steam to rise more quietly, but the vapour is more free from the residual matter of the process.

Our third example is from the sugar boilers. It is customary to throw a lump of butter into the vacuum-pan, for the purpose of preventing that irregular boiling which displays itself in furious bursts separated by apparently almost passive intervals. A gentleman, within the last year or so, has been insisting on the superior advantages of solid paraffin over butter in producing regular boiling.

Fourth example.—Dr. Bostock published, many years ago, an account of some experiments, which excited considerable surprise. Ether (sp. gr. 0·755) in a glass matrass over a spirit-lamp, boiled at 112° Fahr.; but in a test-tube put into hot water it did not boil under 150°, and on one occasion 175°. When some bits of cedar wood were put into the ether, it boiled at 110°: the wood became covered with bubbles until it got soaked and sank. Bits of quill, feather, wire, pounded glass, &c., also lowered the boiling point considerably. Such bodies also renewed ebullition after the liquid had ceased to boil. Plunging a thermometer into the ether produced boiling many degrees below the point at which ebullition took place without the thermometer; the effect soon ceased; but by alternately plunging the thermometer into the ether and removing it into the air, the bubbles were renewed at each immersion. The various bodies used in these experiments are said to act by carrying down air into the ether, and as soon as the air is discharged they cease to act.

Fifth example.—Professor Oersted noticed that if a metallic wire be suspended in a boiling liquid, it instantly becomes covered with bubbles of vapour. To show the application of this fact, 10 lbs. of brass wire, $\frac{1}{8}$ of a line in diameter, were put into a still containing ten pints of brandy; seven pints came over at a heat which, in the absence of the wire, would have sent over only four.

Sixth example.—It is well known in the laboratory that in distilling ether, alcohol, and similar liquids in glass vessels, the vapour is given off with difficulty. At one moment the liquid does not boil at all; at another it bursts into a mass of vapour and liquid, which fills the vessel, and occasions such a bumping of the retort as to endanger its safety, and indeed sometimes to break it. The vapour forms, in fact, with a sort of dull explosion, which is very marked in distilling sulphuric acid. These bumpings are called *soubresauts* by the French. They are mitigated, if not prevented, by introducing into the retort some solid matter not acted on by the liquid. It is recommended to use sharp, or angular, or rough pieces of metal, glass, &c., the points being, it is supposed, favourable to the generation of steam. Silver, platinum, or copper in the form of foil or wire or filings; or bits of cork or cartridge paper are recommended by Dr. Faraday as "promoters of vaporization." He gives a caution against introducing into the retort any one of these substances whilst the fluid is hot, or "it is probable that the consequent burst of vapour would be so instantaneous and strong as to do more harm than the bumping itself. The safer method is to remove the source of heat for a moment, then, opening the tubulature, to introduce a platina wire, letting it touch only the surface of the fluid at first, and introducing more of it as the ebullition occasioned by it ceases. When that is over, the wire should be withdrawn, and the cork, the platina, or whatever, according to the nature of the fluid within, has been selected, be introduced, the stopper closed, heat applied, and the distillation proceeded with." *

It will be seen from the foregoing examples that the three kingdoms of nature furnish these promoters of vaporization, or *nuclei*, as we may call them, from the Latin word *nucleus*, "a kernel," or, as Dr. Johnson defines it, "anything about which matter is gathered or conglobated."

Now the vapour of liquids, at or near the boiling point, gathers about these nuclei; it is our business to-night to enquire, why? That question being answered, we may be able to define the conditions under which nuclei should be selected.

On extending our knowledge of the action of nuclei, we find that they act in liberating gases from solution, as when a bit of cork falls into soda-water, or a fragment of bread into a glass of champagne. The cork and the bread are instantly covered with gas bubbles, and effervescence sets in from each solid nucleus as from a centre.

In the crystallisation of sugar-candy and many saline solutions, strings are stretched across or along the crystallising vessel. The strings act as nuclei, the crystals forming with facility upon them.

Now, what is the constitution of a saline solution? We suspend a lump, say of sulphate of copper or blue vitriol, in water, and watch the process. There immediately pours down from the solid a dense syrupy looking fluid (very different in appearance from the water), and this saccharine-like fluid accumulates, provided there be sufficient salt, until the whole of the water is of that consistence. The solid has lost its character as a solid, that is, it has lost its cohesion; its molecules no longer obey the attraction of cohesion. The adhesion of the liquid has overcome the cohesion of the solid, and we have got a solution, that is, the solid is converted into a liquid. But this adhesive force exercised by the liquid has its limits; it soon begins visibly to decline, it slackens, it comes to an end, and there is still a portion of the crystalline mass undissolved. In other words, the adhesive force of the liquid for that particular solid, at the temperature at which the experiment is performed, is satisfied; the liquid is *saturated*, and the solution is said to be a *saturated solution*. Lower the temperature, the adhesive force of the solvent is diminished, and salt will be deposited. Raise the temperature, the adhesive force of the solvent becomes increased, and more salt will be dissolved. Now suppose we keep the water boiling, say 100 parts by weight of water, and we gradually throw in 209 parts by weight of common potash alum, the water will dissolve the whole of it, and if the solution be set aside to cool, the greater part of the alum will gradually crystallize out. But let us now prepare the hot solution in such a way and under such conditions as to exclude a nucleus, and in the case of aqueous solutions we can do so by making everything we use chemically clean; that is, we use a perfectly clean vessel, clean water, and clean alum, and as soon as we have dissolved the 209 parts of salt, boil up the solution, cover over the vessel with a watch glass, or plug it with cotton wool, and we get this unexpected result; the solution in cooling does not deposit any of its salt as it did before, when no pains were taken to exclude a nucleus. The solution will now cool down to the temperature of the air, when, holding as it does, a larger quantity of salt than it can take up at that reduced temperature, the solution is said to be *supersaturated*. Now according to Poggiale's table, 100 parts of water at

C.		Fahr.			Parts.
100°	or	212°	will take up of crystallised	potash alum	357·48
90	„	194	„	„	209·31
80	„	176	„	„	134·47
70	„	158	„	„	90·67
60	„	140	„	„	66·65
50	„	122	„	„	44·11
40	„	104	„	„	30·92
30	„	86	„	„	22·01
20	„	68	„	„	15·13
10	„	50	„	„	9·52
0	„	32	„	„	3·90

That is, 100 parts of water at 212° will take up about 357½ parts of salt; at 140° only 66 parts; at 68° only 15 parts; and at 32° not quite four parts. Now, supposing we have complied with the conditions as to the exclusion of a nucleus, our boiling solution, containing 209 parts of alum, may be cooled down to the freezing point of water without any separation of the salt from solution; that is, the water at 32° will hold 53½ times more salt in solution than it could take up at that reduced temperature. I have several of these highly supersaturated solutions on the table. They are perfectly liquid, and can be shaken about without crystallizing. Why do they continue thus to maintain their liquid state? My answer is because there is no nucleus to start the action. I take out the cotton wool from this flask, and the solution instantly becomes solid, with considerable elevation of temperature. I touch this solution with a glass rod, or a bit of wire, and it immediately solidifies.

This, you see, brings us back to the action of nuclei. I can show the action of a nucleus better by means of a supersaturated gaseous solution, such as soda water, seltzer water, or champagne. You are aware that cold water will take up or dissolve its own volume of carbonic acid, and this also is a case of adhesion leading to change of state; the adhesion of the water does not, as in the former case, overcome cohesion; it rather overcomes repulsion; it converts by its adhesive force a highly elastic gas into a liquid. In this bottle of soda water we have one volume of carbonic anhydride dissolved in one volume of water, while a second volume of the gas has been forced into the water by machinery, and is now retained by the pressure of the cork. We may call this a supersaturated solution of carbonic anhydride in water. I pour some of this soda water into a test glass, and we have the usual effervescence and escape of gas, and also a multitude of gas bubbles clinging to the sides of the glass. Now observe. I can renew the effervescence at pleasure by putting in a solid, such as a strip of paper, a glass rod, my finger, a cedar pencil, iron filings, &c. Any nucleus, animal, vegetable, or mineral, put into the soda water will produce a separation of gas. In other words, there is a stronger adhesion between the gas and the nucleus than between the gas and the water.

Now, let us go over precisely the same ground, with this single variation in the apparatus, namely, that we *de-nucleize* it, so to speak, which we can generally do when dealing with aqueous solutions, by making it chemically clean. I pour soda-water into a clean test-glass; there is effervescence as before, but there are no bubbles adhering to the glass. I put in a glass rod made similarly clean; there is no escape of gas; clean iron filings produce no effervescence. I insert the other, or unclean, half of the glass rod into the solution, and there is an abundant liberation of gas; I throw in unclean iron filings and we get a noisy boiling effervescence.

---

* "Chemical Manipulation," 1830, p. 200.

What is the reason for this? Why should an ordinary glass rod act as a nucleus in liberating gas, and when made chemically clean refuse to act? We are still dealing with a case of adhesion; the gas adheres to the unclean rod in preference to the water; but in the case of the clean rod, the solution adheres to it as a whole; that is, there is at least as strong an adhesion between water and a chemically clean surface as there is between water and the dissolved gas; the solution adheres to the clean glass rod as a whole, and hence there is no separation of gas.

But why all this? Why should this difference in adhesive force be manifested in one case and not in the other? What do you mean by an unclean surface? These are perfectly fair questions, and I will answer the last first.

By an unclean surface, as used with reference to aqueous solutions, I mean a surface that is contaminated, ever so slightly, with oily, greasy, or fatty matter; and to this sort of matter water adheres with much less force than gas, or salt does. Now this kind of matter is everywhere present. Everything that we touch is contaminated with an organic film more or less greasy; the very act of touching it makes it so; everything that is exposed to the products of respiration, to the air, to the dust of the room, is coated with such a film. A glass washed in water and wiped with a so-called clean cloth has an irregular coating of greasy matter to which water adheres with less force than gas does, and hence, in such a glass, soda-water gives off its gas to the sides, and this gas clings to it in the form of bubbles. Make the glass clean and then the water adheres to the sides with as much force as the gas which it holds in solution, and there is no separation of gas. So also the dust of the room is a powerful nucleus; collect it, wash it in a caustic alkaline solution, and it is no longer a nucleus; it will not separate gas, or salt, or steam from solution.

If I have expressed these preliminary details with sufficient clearness, you will be able to apply them to many of the phenomena of boiling liquids, and to explain the six cases with which I commenced this paper. According to my view, a liquid (water, for example), at or near the boiling point, is a supersaturated solution of its own vapour. It will part with its vapour to a nucleus, but adheres, as a whole, to a chemically clean surface. An unclean nucleus may become clean in the course of an experiment; it may act very well at first, and gradually cease to act. Every chemist knows this, but I will give you an example:—Here is a flask containing distilled water and a little white sand. I boil the water, and the boiling goes on briskly, but with no kicking. Here is a similar flask, containing perfectly clean sand, which is not a nucleus, as the unclean sand is. The boiling is accompanied by a number of violent bumpings, amounting to dull explosions, sufficient to endanger the vessel. In the former case, when the sand acted as a nucleus, each grain performed the function of a vapour-giving surface; but in the case now before us, in which the sand has been denucleized, we multiply the adhesion surfaces: that is, the water, with its charge of vapour, adheres not only to the sides of the clean vessel, but also to every grain of sand, so that the temperature of the boiling water is raised some degrees above the boiling point. Under these circumstances the steam accumulates in the liquid, until the latter becomes so highly charged that it can hold no more; the steam escapes with a burst, and is discharged along the line of least resistance, namely, out through the neck; this upward action is accompanied by a corresponding and equal reaction, a motion downwards, which tends to drive the flask further into the ring of the retort-stand, and it is the rebound from this that constitutes bumping or jumping ebullition. That this explanation which I venture to give is the true one, may be proved by suspending the flask by means of a weak spiral spring, or a piece of elastic, and applying the lamp under it. It will be seen that every kick is accompanied by a downward jerk of the vessel.

A nucleus, then, is a body that has a stronger adhesion for the gas, or the salt, or the steam of a solution than for the liquid which holds any one of the three in solution.

That a boiling liquid is a supersaturated solution of its own vapour may be proved by holding a nucleus in any part of the liquid. It will instantly be covered with steam bubbles.

The radicles of malt thrown into the boiler acted as a nucleus in consequence of the oily and other unclean matter thereby introduced, which enabled the steam to escape more readily from the water.

The soap used by the distillers, the butter used by the sugar refiners, the bits of cedar-wood, &c., employed in Dr. Bostock's experiments, the brass wire used by Oersted, the pointed or rough bits of platinum, &c., used by chemists, are all nuclei more or less durable, which have a stronger adhesion for the vapour of the solution than for the respective liquids, whether water, alcohol, ether, &c., which hold the vapour in solution.

But all these substances, which have hitherto been used empirically because the principle which led to their adoption has escaped notice, are liable to objection. They require to be renewed at each operation; and, also, they often cease to act during one operation. It has been recommended to use sharp-pointed or roughened bodies, under the impression that steam is given off with greater facility from the points or the teeth. This is a mistake. Make these rough or sharp-pointed bodies clean, and they cease to act. Sharp, angular fragments of glass, washed in sulphuric acid and rinsed, no longer act as nuclei. A rat's-tail file, passed through the flame of a spirit-lamp, also becomes denucleized. A body such as a file is apt to collect between its teeth the greasy kind of matter that acts so well as a nucleus; and this has led to an idea in favour of rough bodies. The air is not a nucleus. When Dr. Bostock found his thermometer cease to act, and by taking it out of the liquid and waving it in the air, it liberated vapour when restored to the liquid, the thermometer had caught from the air some unclean particles of dust, which acted for a moment as nuclei, until, by the action of the ether, they become denucleised. So, also, in the cases of sudden crystallization, which you have witnessed to-night; it was not the air that acted as the nucleus, but some particles of dust floating in the air that started the act of crystallization.

I should be glad to show you the action of nuclei on various liquids at or near the boiling point, but as some of them are very inflammable, I could not do so with safety on a scale sufficiently large to be seen by an audience, but I will just notice from my own experiments a few points in their behaviour.

Carbonic disulphide (bisulphide of carbon), from its low boiling point, gives off vapour with facility. If a tube containing this substance be plunged into hot water the liquid quickly attains the boiling point. On touching the surface of the liquid with the end of a brass wire, violent ebullition set in. The boiling ceased as soon as the wire was removed, but when the surface was touched with a strip of paper it set in as violently as before.

Now in these two experiments no air could have been carried down, since the surface only was touched, and the boiling continued only while the solid was kept in contact with such surface. Iron wire also liberated vapour in abundance. The end of a glass rod was active at two small points, liberating from each a rapid stream of bubbles, the remaining portions being made clean by the action of the hot liquid, since glass is readily cleaned by liquids near the boiling point.

The hot liquid was touched with a rat's-tail file, and it produced furious boiling. The file was held in the flame of a spirit lamp, and while hot placed in the upper part of the tube, so as to cool out of contact with the air. On touching the surface of the disulphide with the end of the file, there was no liberation of vapour, and the file was passed slowly to the bottom of the liquid, but still there was no action. The file was taken out and waved in the air; on returning it to the liquid there was a burst of vapour arising from motes or specks of dust that the file had caught from the air.

Ether was raised to the boiling point, and a pellet of paper thrown into the tube. The liquid boiled up furiously, the paper being much agitated, when suddenly it sank as if struck dead, and all vapour-giving action ceased. It had in fact become chemically clean. The paper was removed, and a brass wire passed down to the bottom of the tube, when the liquid boiled up briskly during a few seconds, but on the wire becoming clean all action ceased, except from a point near the bottom of the wire, which poured off a stream of bubbles. The wire was taken out and filed, in order to get rid of this nucleus, but the active point was not got rid of, for there were now two such points giving off rapid discharges of vapour. These points are probably bits of porous dross entangled in the metal.

Methylated spirit boiling at 171° F. was kept at about that point. A piece of flint was put into the tube, abundance of vapour was given off from its surface. The flint was taken out and broken, and the two fragments were returned to the vessel. The newly-fractured surfaces being chemically clean, were quite inactive, not a single bubble of vapour appearing on them, while the old surfaces continued to give off vapour as before.

I have performed a very large number of experiments on the action of nuclei on various liquids at or near the boiling point, and they all point to the same conclusion, namely, that the action of a nucleus is differential, there being a greater amount of adhesion between the nucleus and the thing dissolved than between the nucleus and the liquid. In the great variety of cases the nucleus is contaminated with some kind of oily, fatty, or greasy matter, and this having a less adhesion for the liquid part of a solution than for the gas or the salt or the vapour of such solution, there is, consequently, a separation of gas, or salt, or vapour. The nucleus may be a solid thrown into the vessel, or the sides of the vessel may act as a nucleus, or fatty matter may be thrown in, in order to make the vessel unclean, as in the case of the distillers and the sugar boilers. But in all cases of solid or liquid nuclei, we may always observe this differential kind of action, on which, as I contend, the action of nuclei depends. It is not my business to-night to combat existing theories, or to disprove the notion that nuclei act by carrying down air, and that when a liquid is deprived of air it cannot boil at all. Such theories have been, and are being discussed, elsewhere; my business here is of a practical, not of a theoretical kind; but I may perhaps be allowed to quote one more case to justify my view of the action of nuclei.

Five ounces of distilled water in a clean flask boiled at $213\frac{17}{20}$° Fahr. Some perfectly clean mercury was poured in, enough to form a ring at the bottom of the flask. The water rose to 214°, with much bumping, steam forming under the mercury, and distending it into hemispheres, each of which burst with a kick. It would have been dangerous to have entirely covered the bottom of the vessel with the metal, for, as it was, the bursts were of an explosive character. While this uneasy boiling was going on, a very little dirty mercury was added to the flask, and, although the quantity was not more than one-sixth of that previously added, the effect was remarkable. Instead of the uneasy kicking, jerking bursts, the boiling became brisk, easy, and soft, rapid volleys of steam-balls being given off by the metal, breaking up the mass of water, while the temperature remained steady at $212\frac{2}{20}$°.

Now, all these "promoters of vaporisation," as they are called, or nuclei, as I prefer to name them, whether bits of metal or glass, bits of paper or wood, soap, butter, paraffin, &c., are liable to the objections already stated, that they cease to act by use, and require to be renewed after each, or even during the same operation.

But there is a kind of matter that is not liable to these defects, which I have not been able to make inactive, either by the action of the strongest acids, or caustic alkalies, or by repeated boiling in water, ether, alcohol, naphtha, &c. I mean porous bodies, such as charcoal, coke, pumice-stone, meerschaum, and a few other bodies. These act by means of the powerful force of capillarity. The same force which, according to Saussure, enables one volume of boxwood charcoal to absorb 90 volumes of ammoniacal gas, 85 of hydrochloric acid gas, 65 of sulphurous acid gas, and so on, enables these porous bodies to absorb vapour from boiling liquids, and, under the continued action of the heat, to give it out in never-ceasing jets, thus relieving the vessel of all tendency to bumping, making the boiling soft, gentle, and regular, and increasing the quantity of the distillate.

Charcoal, or some other porous body, is, then, the proper nucleus in the case of boiling *liquids. It is* quite remarkable to see how efficiently a lump of coke acts in a vessel of boiling water in giving off vapour, promoting tranquil boiling, and preventing the jumping of the vessel. Not the least important service of these porous nuclei is the fixity they confer on the boiling point. When a liquid is boiling in a clean vessel, and in the absence of nuclei, it may go on dissolving steam until the liquid becomes more and more highly saturated with it, and during this period the phenomena of boiling cease, and the temperature rises some degrees above the boiling point. Here is a very delicate thermometer constructed for me by Mr. Casella for showing this rise, and measuring it accurately in 20ths of a degree. He has also constructed a themometer on a large scale for showing this fact to you to-night, and I shall be happy to do so at the end of the paper. But I may state that this delicate thermometer, graduated into 20ths of a degree, commences its scale at 204° F., and terminates at 215°, but this is not high enough, for although we are taught that when the pressure is at 29·8 inches water boils at 212°, yet under that pressure, in a chemically clean vessel, water may not boil until it reaches 218° and upwards. I have repeatedly had to snatch this thermometer out of the vessel when I saw the mercury rising rapidly to the top of the tube, for, had it reached the top with its ascensive force unchecked, it would infallibly have burst the bulb.

It is interesting to watch this thermometer when it marks temperatures below its extreme limit of 215°. When the bulb is in boiling water the mercury is not still for an instant. It is constantly oscillating like an uneasy pulse which marks the uneasy action of the heart; so the mercury in the stem marks the uneasy action that is going on in the liquid. The formation of steam in the liquid is indicated by a rise, the bursting of a bubble by a fall. The most considerable rise and fall is when the boiling ceases and steam accumulates, and there is a sudden burst accompanied by a kicking of the vessel. This uneasy kind of action, so manifest on a small scale, must be a mighty force in a steam boiler, or a large still or retort. No wonder that attempts have been made to remove or to mitigate this irregular kind of action by means of nuclei; but I venture to say that in the majority of cases the proper nuclei have not been selected. So far as I know they should always be porous bodies of such a nature as not to be acted on by the liquid.

As there is nothing like comparative numerical results for testing processes against each other, I give the following among many obtained at my request by my friend Mr. Hatcher:—

1. A glass flask with a wide neck was filled about one-third with distilled water; it was boiled over a gas burner, weighed rapidly, and replaced over the burner. After boiling twenty minutes it was weighed again. The flask was once more filled to the original quantity, and some bits of coke were added; it was boiled and weighed as before, the gas flame remaining unaltered all the time.

Results.—Water boiled away in the first trial (water only) 995 grains; in the second trial (with coke) 1,130 grains.

Ratio of products 100 : 113·6.

2. Water was made to distil freely from a still, and the quantity collected in fifteen minutes was weighed. A few pieces of coke were then added to the water in the still, and the distillate collected again during fifteen minutes.

Results.—Distillate from water only 293 grains; from water with coke 310 grains.

Ratio of products as 100 : 105·8.

3. A similar trial was made with common wood charcoal, but the vessel having been made much cleaner by the action of the first boiling, the water boiled irregularly, with bumping. The addition of the charcoal made the boiling tranquil and regular.

Results.—Distillate from water only 262 grains; from water with charcoal, 334 grains.

Ratio of results as 100 : 127·4.

The following results are from my own experiments:—

Methylated spirit was distilled in a glass retort at a fixed boiling point of 171° Fahr. The distillate collected in five minutes was weighed, and found to amount to 244 grains. Three or four fragments of charcoal, partly from boxwood and partly from cocoa-nut shell, weighing altogether 20 grains, were now added to the retort, and when the spirit was again fairly boiling the distillate during five minutes was again collected and weighed. It was now found to amount to 325 grains. The ratio of the results is as 100 : 133·2.

Instead of charcoal, 20 grains of fine ground pumice-stone in four fragments were used in the retort, when the ratio of the results was as 100 : 121·7.

With 20 grains of meerschaum as 100 : 112.

With 20 grains of coke as 100 : 107·46.

These numerical results are, however, very much understated if compared with those obtained in a retort that is structurally free from nuclei, which was by no means the case with the retort actually employed. Indeed, it is seldom that we get a retort or a flask, or even a test tube that is free from porous specks of ferric oxide, or of carbon. These become attached to the glass in the process of manufacture while it is still soft, and they act as small but powerful nuclei in separating vapour from hot liquids, and preventing bumping. Indeed, were it not for the presence of these accidental impurities, many a chemical operation must fail from the fracture of the vessel from excessive bumping, and chemists would have only too close an acquaintance with the phenomena of *soubresauts*.

Charcoal, coke, pumice, and other porous bodies, are especially valuable in distilling those liquids that are of such a nature as to exert a powerful action in cleaning the inner surface of the retort or of the still. Such liquids as alcohol or spirits of wine, ether, naphtha, benzole, sulphuric acid, &c., act in this way, and the sides of the vessel no longer performing the useful function of a nucleus, the adhesion of the liquid to the sides of the vessel is so strong that the vapour accumulates in it, and only escapes in explosive bursts, separated by almost quiet intervals. These porous nuclei render the boiling and the liberation of vapour quite easy. Even in thick syrup of sugar, boiling at 240° Fahr., they are still active, and with their assistance I have in the course of a few minutes driven off so much water from a syrup boiling at 218°, that it soon reached 240° and cooled down into a clear semi-solid mass in a flask, into which a plug of cotton wool was inserted when the lamp was removed. Here is a flask containing a syrup that boils at about 220°. It contains a small lump of coke, one or two bits of cocoa-nut shell charcoal, and a bit of pumice. I shall be happy to set this flask boiling.

Charcoal from cocoa-nut shell is a good nucleus. It is very dense, and will occupy the bottom of the vessel that contains liquids somewhat denser than water. It is at the bottom, or near the bottom of the vessel that the nucleus is most efficient, and for dense liquids the porous nucleus may be loaded with some heavy metal that the liquid does not act on. Coke, though a less powerful nucleus than charcoal, is convenient from its being always at hand, and presenting itself in lumps of any size. I have no doubt it will be found of use in steam boilers, and may be used instead of the radicles of barley, the soap, the butter, and the paraffin, &c., already noticed.

I have already said that these porous nuclei act by the force of capillarity, and so powerful is this force alone that it can be applied in a variety of ways. Even a short bundle of fine capillary fibres, united like a faggot by a thread in the middle, is an active nucleus in liberating vapour. Such a bundle, weighing only ten grains, put into a retort from which methylated spirit was being distilled, raised the amount of distillate in the ratio of 100·110.

Where circumstances admit of it, we may apparently increase the nucleus power even of charcoal by first boiling it in a liquid of higher boiling point than that of the liquid to which it is to be transferred. Thus a piece of charcoal that had been used in boiling turpentine seemed to be more active than pure charcoal in liberating vapour from boiling water. The charcoal is not only porous but unclean, and hence its activity. I have not tried it against clean charcoal in quantitative experiments; hence I only say that it seems to be the more active of the two.

I have no doubt that a large number of processes in the useful arts will be assisted by a clearer knowledge of the action of nuclei which I have thus briefly attempted to explain. It is the natural result of scientific labour to reduce to law the empirical practices of industry. As soon as an intelligent manufacturer knows the principle upon which he works, he can improve and cheapen his processes by an increased production, or by economy of fuel, or by simpler apparatus, or less labour, &c. I believe that these ends may be attained by a judicious application of nuclei in the vast number of cases where it is required to raise vapour from liquids by the process of boiling. The proper applications of such nuclei might be made the subject of several patents; but I have so great a horror of patents, especially under the present laws and practice, that I prefer to bestow this application of some of my recent scientific researches as a free gift to the useful arts, rather than hamper it with any conditions.

What I claim to have discovered is the action of nuclei in liberating gas, or salt, or vapour from solution; and the behaviour and proper application of nuclei in various processes in the useful arts. Bodies have long been used for promoting vaporisation, crystallisation, &c.; but how they acted, and why they often suddenly ceased to act, was not known. We have many theories about the "mysterious action of air," "catalytic action," "molecular change," &c., which have borne no fruit; whereas, according to my view, supported as it is by hundreds of experiments, all the varied phenomena of nuclei may be explained by the varying force of adhesion and capillary action.

DISCUSSION.

The Chairman remarked that the subject of the paper was a most important one, and extended in its various ramifications almost throughout the whole range of the useful arts, from the housewife's tea-kettle up to the locomotive engine. In proportion as boiling could be effected more readily, so would the power of boilers be increased, or their size and weight diminished. He should be much obliged to any gentleman who had any remarks to make on this important subject.

Mr. Bramwell said the matter brought before the meeting was one more suited to a chemist than to a mechanical engineer like himself; but there were some points on which he might venture a remark or two. Mr. Tomlinson had suggested that if the kind of explosion which had been going on in the small retort were magnified to a proportionate extent in a large steam boiler the effect would be tremendous; but he (Mr. Bramwell) did not think there were any instances recorded of such results, which might perhaps be accounted for by the fact that boilers, instead of being too clean, as was the condition of the vessel instanced in the paper, were generally far too dirty. When the use of surface condensers was lately revived for steam engines, there was a fear on the part of some engineers that the water, being entirely deprived of air, might, in boiling, cause these constant explosions; that, however, had not been found to be the case, and the only difference really was that the distilled water, from certain circumstances which need not now be entered into in detail, occasioned more rapid corrosion of the boiler. This had been easily remedied by the introduction of a small portion of undistilled water, which protected the plate by a slight deposit. He (Mr. Bramwell) was not a chemist, but he had endeavoured to follow Mr. Tomlinson in his paper, and he understood him to say that he looked upon the nuclei (especially those porous bodies which he preferred, as being constant in their action) as acting by possessing a greater attraction for the vapour than the water had, and thus extracting from the water the vaporous particles. That he could understand, but he did not quite see how, if they had so great an attraction for the vapour, it was given off again from them so readily. No doubt there was a good chemical answer to this difficulty, which perhaps might be given. An answer, but a mechanical one, suggested itself to him as being possibly the correct one, was this:—That if a vessel of water were heated at the bottom, vapour was there generated which was desirous of ascending all over the vessel, in no one part more than another; that vapour was in a state of unstable equilibrium, but if it could be induced to ascend in any one part, that condition of things would be relieved, and there would be a continuous easy flow. Otherwise the steam would go on accumulating until the pressure was too great to be borne, and then there would be a gush or semi-explosion. Now, if in a vessel of boiling water there was any matter coated with particles of steam, it appeared to him that the parts immediately adjacent to this matter would form an easier channel through the water for other particles of steam; in other words, that a bubble of steam would find its way through the water with less difficulty when on one side of the channel there was a film of steam, than where it had to go through the water entirely. A very coarse practical illustration of that fact was tried in America at the time when he (Mr. Bramwell) was there, by the owner of steamboats running from New York to New Jersey, who thought he could get rid of the friction of the water by interposing a lubricating film of air between the skin of the boat and the water, which he accomplished by making a series of open channels below the bottom, into which air was pumped at the bow, and escaped at the stern. There could be no doubt that in this way he obtained the desired result, although at such an expenditure of power as to render it practically of no value, and therefore he (Mr. Bramwell) mentioned it merely as an illustration of what he had been saying, and not as a useful fact in steam navigation. If this idea were correct, then the porous material which, in the first instance by capillary power, attracted particles of vapour to itself, would act, not by giving it off again,—which seemed to him an anomaly—but by forming a channel, one side of which was a film of vapour. He (Mr. Bramwell) might further remark, that when a current was once established in this or any other way, it was comparatively easy to keep it up, because when once the particles of steam—or carbonic-acid gas, in the case of soda-water—were got to ascend in one place rather than in another, that column, being a mixed column of water and steam, would be lighter than any other part of the liquid, and thus an up-cast and down-cast shaft or current would be established, and this might account for the regularity of the boiling when these porous matters were used. There was one matter on which he should like a little further information. He had understood Mr. Tomlinson to say that in certain cases the amount of produce from a given still was increased by the introduction of porous bodies as much as 33 per cent.; was it intended to be conveyed that this result was obtained without any increased expenditure of heat? because if that were so they would have to reinvestigate the question as to the amount of heat required to convert a given quantity of water into steam. If it merely meant that out of the same sized vessel exposed to a certain heat more steam was obtained, then the difficulty that the result was at variance with accepted laws would not occur, as the result could be explained by simply assuming that more heat was utilized. He would, however, just throw out the suggestion whether or not the supposed extra steam thus produced was absolutely dry steam, because there was a state of things, well known to engineers in trying the evaporative powers of various boilers, under which a large quantity of water disappeared out of them, not all in the form of dry steam, however, but partly in that of water carried along with the vapour, which state of things was technically known as priming. There was another matter, somewhat connected with the subject of the paper of which he should be glad to have an explanation; engineers were in the habit when a low pressure boiler (say with steam from 6 lbs to 25 lbs. to the inch), was primed, of injecting with a syringe a certain amount of grease into the lower part of the boiler, which was found to stop the priming; but on the other hand, in the case of a high pressure boiler, such as that of a locomotive engine, priming was commonly ascribed by the engine driver to his having greasy water; so that what was considered a cure for a low pressure boiler caused or aggravated the evil in a high pressure one. He understood Mr. Tomlinson to say that a chemically clean surface would be wetted by water rather than by a vapour or gas, whereas, if greasy, water would not wet it, while vapour or gas would. This being the condition of things, a possible explanation of the use of the introduction of grease might be, that if in a boiler there were only a few strong local currents, which caused priming, the injection of grease might "dirty" large portions of the boiler surface, and thus form, as before explained, channels up which the steam might pass, and thus set up a general instead of a local delivery of steam, which was commonly the cause of priming. He might mention, in conclusion, that in 1839 Mr. Armstrong published a new edition of his work on the boilers of steam engines, and on the saving of fuel, and between pages 130 and 139 would be found engravings of boilers, with pieces of brick or other matters put into them, and steam-bubbles arising therefrom, which pieces of brick Mr. Armstrong called "steam generators." He (Mr. Bramwell) fancied the right term would be "steam separators," as he could not imagine that putting bricks into a boiler would raise steam. Then, again, many years ago, at the time the Blackwall Railway was first opened, there was an old engine of Bolton and Watt's at work at Rotherhithe, and the foreman, having put some pieces of oak from a shipyard into the boiler for the purpose of keeping it clean, declared that he immediately got more steam. He (Mr.

Bramwell) should certainly like further particulars about the use of barley radicles in Scotland, because, as he understood the statement in the paper, it pointed to a most extraordinary, and, if correct, to a most important result. This result was, that in a steam-engine boiler there could be obtained more steam for the same expenditure of heat when the barley was used than when it was not. It was true this was only repeating that which had been alleged in the case of the small experimental stills, but it was doing it upon a large and practical scale. The statement was, that when a boiler had become so much encrusted as to cease to produce the required amount of steam, the workman, rather than stop the engine for the purpose of cleaning the boiler, would put into it some barley, and then they immediately got more steam than before. He (Mr. Bramwell) presumed that barley could not add to the conducting power of a dirty boiler; and therefore he was at a loss to know how the result was to be explained short of alleging that, when it happened barley was present, by the same expenditure of heat a greater amount of steam was produced—or, which was the same thing, an equal amount of steam was got by a less expenditure of heat.

Mr. Warriner said he could, in some measure, confirm the statements made in the paper by his own experience in the course of making experiments in cooking for the War Department. It was found at Woolwich barracks that by putting oyster-shells into the boilers, food for from 50 to 100 more persons could be prepared. The waters of Kent, Surrey, and Sussex were very much charged with chalk and silica, which caused a great deal of deposit on the boilers, but the introduction of the oyster-shells, or similar substances, prevented that difficulty. Various other matters, such as barley and oak sawdust, bad been tried, but nothing equalled lime, oyster-shells, or flint stones. He had also found in the preparation of preserved food in tins, which was boiled in a bath of chloride of calcium, that if a film of oil or fat were poured upon the chloride, an addition of from 12° to 20° of heat was obtained. He had searched every work he could think of in English, French, or German, to endeavour to find the reason of this, but could not succeed, and should like to have an explanation.

Dr. Pearse begged to suggest the question whether the phenomena which had been described were not due to an electrical action, and asked whether Mr. Tomlinson had observed the electric relation existing between the vessel and the fluid contained within it. They knew that in the generation of electricity, largely increased results were obtained from surfaces presenting a number of infinitesimal points; the difference in this respect between the plane surface of an electrode, and one which had received an electric deposit of metal, was very great. From some experiments which he had made in galvanic electricity, he found that the quantity of electricity was trebly increased by simply roughening the surface of the electrode.

Mr. Casella said that as an illustration of the peculiar difficulties caused by the variation in the boiling point of fluids, he might mention that some few years ago, when various methods were being devised for ascertaining the amount of spirit in sweetened solutions, a patent was taken out for a process which seemed thoroughly efficacious, except for the uncertainty that was found to exist as to the boiling point. At that time he was not aware of the uncertainty that existed, it being generally supposed that water boiled at 212°, under certain conditions as to the pressure of the atmosphere, the cleanness of the water, &c. When the theory came to be applied, however, it was found that the turbulent manner in which the boiling was carried on was an almost insuperable difficulty in the application of what would otherwise have been a most admirable process. The introduction of iron filings and various other matters was tried, with tolerable success, but not with so much as could be *desired*. In determining heights by means of the boiling point of water, this difficulty was found to be almost insurmountable, for although there was no doubt that the height could thus be accurately ascertained, great practical difficulties arose from the uncertain and irregular way in which the water boiled, and, notwithstanding that this method had been in use for many years, comparatively little progress had been made. The difficulty had, however, now been overcome, by means of a simple apparatus, by which the thermometer could be kept, not in the boiling water itself, but in the steam or vapour given off from it, immediately above the surface, and in this way the difficulty was obviated.

Mr. Tomlinson said that to reply adequately to the various remarks and suggestions which had been made would require a whole evening, but he would briefly touch upon what seemed most important. He was not aware of the recommendation in Armstrong's book referred to by Mr. Bramwell, but it was quite probable that such had been made empirically; what he contended for was the discovery of the principle. *The next question*, which was of considerable importance, was as to how he accounted for the increase of the distillate. In the first place he must say that in all these experiments he had used either water or methylated spirit, whose boiling point was fixed at 171°. Under these circumstances, by the addition of three or four fragments of charcoal, weighing only twenty grains, he had obtained at least one-fourth more distillate. He did not want it to be supposed that he had created any new force, but simply that he had economised heat, by preventing its being wasted in those energetic bursts and jerks, which of course exhausted a certain amount of heat. As it had been well said, a large amount of the power of a locomotive was expended in bumps from irregular junctions of the rails, and so on, and whether force was wasted or usefully employed, it must equally be paid for in some way or other. If they had a vessel which boiled tranquilly occasionally, then ceased, then boiled with violent bursts, then subsided again, and so on, it was evident there must be a great waste of heat. In all these experiments he had used a thermometer, and *never found that* the introduction of the charcoal or other nucleus affected the temperature of the boiling point in the slightest degree; its action, therefore, was to prevent the bumping, and to enable the steam to come over easily and gently. He was perfectly certain that in each case the steam was dry; the retort had a very long beak, and the receiver at the end was plunged in cold water, constantly renewed, and the same gas jet was employed all through the comparative experiments. When a retort was put over a gas jet there was a great deal of heat wasted, indeed, he did not know of a single case in connection with the arts in which the whole of the heat employed was utilised. There was a considerable waste in heating a retort by means of a Bunsen's burner or a ring of jets, but with the nuclei the heat was economised; that was all he contended for. With respect to the action of porous bodies in promoting ebullition, the theory originated with De Luc more 100 years ago, that water deprived of all air could not boil; that theory had recently been revived, and some remarkable experiments had been made by Mr. Grove and others. In the current number of Poggendorf's *Annalen* it was stated, as a known fact, that it was impossible to deprive water of all its air, the inference being that it was in consequence of the presence of a certain quantity of air dissolved in the water that the steam was enabled to be formed. It had been his business for some time past to overturn that theory, and he should not rest until he had done it. Water, at say 40°, would dissolve $\frac{1}{50}$ of its bulk of nitrogen, and about $\frac{1}{25}$ part of oxygen, but so soon as the water was boiled he contended that all the air was expelled, and that if a chemically clean vessel of boiling water had its surface carefully covered with oil, there would be no absorption of air. Mr. Grove said there was, but this was not the proper time and place to discuss that question. He entirely denied the truth of the air theory of ebullition. His definition of boiling, which he thought was supported by a very large number of experiments, was, that a boiling liquid was a supersaturated solution of its own vapour. The proof which he had given of this in his illustrations was, that if you lowered a nucleus into a liquid, no matter what its volume, at or near the boiling point, steam was instantly disengaged. That could not be through raising the temperature, because the introduction of a cold rod of glass or metal would rather tend to lower it, but yet the rod would immediately become covered with steam bubbles. His contention was, that the action of porous bodies was precisely that which was pointed out so ably by De Saussure some years ago, in his two classical memoirs on the absorption of gases by charcoal and other porous bodies. In a well-burnt piece of charcoal there was an enormous amount of surface, more almost than would be readily believed, for a piece the size of his thumb-nail had a surface of many square yards. It was this extensive surface which illustrated in the clearest manner the force of adhesion, for when such a substance was thrown into a liquid or a gas it instantly absorbed it largely. Charcoal would absorb 98 times its own volume of certain gases. Accepting his definition of a boiling liquid, one which was supersaturated with its own vapour, when a piece of charcoal was introduced, presenting such an enormous surface for adhesion, De Saussure's law immediately came into operation, and there was an absorption of the vapour. There were thirty or forty liquids, the vapour of which charcoal would powerfully condense at or near the boiling point. If the heat were condensed he believed there was a constant interchange of particles of vapour, some being constantly absorbed and others being constantly given out. On watching the action of a piece of coke or charcoal, or even a bundle of capillary tubes, it would be seen that there was a rapid absorption, and under the continued action of heat a rapid expulsion of the vapour, and the result was that uneasy and fitful boiling was got rid of, and thus heat was economised. He believed that manufacturers engaged in distillation would find it much to their advantage, instead of using soap and various other obnoxious articles to promote ebullition, to know the *rationale* of the thing, and to use coke or charcoal. Referring to the remarks of Mr. Warriner, he had no doubt that oyster-shells would form very good nuclei, but he had not found that flint stones were so, because they soon became clean by the action of the boiling liquid, and then their presence was a positive mischief rather than an advantage. With reference to the increased temperature obtained in the bath of chloride of calcium by coating the surface with a film of oil, he had no doubt the effect was to prevent superficial evaporation. In a bath at 260° the surface would be constantly throwing off vapour, thereby causing a great waste of heat, and by using a film of a fixed oil, which would not boil at all, or of oil which only boiled at a very high temperature, this would be prevented. He did not conceive that the electrical condition had anything to do with the phenomena under discussion, but he was much obliged for the suggestion, and would direct his inquiries in that direction, which hitherto he had not done. Sir Humphrey Davy once made some experiments with a voltaic battery which he was not able to explain. He endeavoured to obtain a current by means of pairs of plates of the same metal, but did not succeed if the plates were clean. If, however, one of the plates were slightly smeared with grease, he found that a current was obtained. That phenomena had never been explained, but to him (Mr. Tomlinson) it was quite clear that in a cell where gas was being generated by one plate, and electricity by the other, the second plate could not conduct unless it could separate the gas from the liquid; for if the gas accumulated it prevented the action of the plate in conducting electricity. It was, therefore, necessary to have the other plate in such a physical position that it could attract the gas. Mr. Casella had made some remarks on turbulent boiling, which had been perhaps sufficiently touched upon in the paper, and also on the variation in the boiling point. He ought to say, in reference to this latter part of the question, that in all his experiments the boiling point was fixed. Many years ago the irregularity of the boiling point was much discussed by the Hon. Mr. Cavendish, De Luc, and others, and it was found to vary according to the nature of the vessel and the depth to which the thermometer was plunged in the liquid. The Royal Society issued a commission on the subject, composed of some of their most distinguished Fellows, whose report would be found in the Transactions for 1777. In this report they stated that the boiling point varied according to the depth to which the thermometer was plunged, and also according to the nature of the vessel, whether it were of glass or metal. They also stated that if water were boiled in a metal vessel, and the bulb of the thermometer and that part containing the mercury were not placed in the water, but so as to be surrounded by the steam given off from the surface, it would be found that the boiling point was perfectly fixed; the steam directly it left the water instantly accommodated itself to the pressure of the atmosphere, and always showed 212°; so that in graduating for the boiling point all that was necessary was to suspend the thermometer in the steam. Mr. Casella had taken advantage of this principle to construct a very convenient little instrument for ascertaining the heights of mountains by means of the boiling point. At the sea-level water boiled, under the pressure of 29·38, at 212°, and for every 535 ft. of ascent, the temperature was lowered one degree, so that at the top of a high mountain, such as Mont Blanc, it would boil at 188°, or not hot enough to cook food. Mr. Tomlinson concluded his remarks by exhibiting and describing one of the instruments alluded to, which was shaped somewhat like a small telescope in an upright position, the lower and broader end holding a boiler and spirit lamp, and the steam ascending to the upper part, into which the thermometer was lowered through an elastic ring or collar.

The Chairman thought it had been clearly shown by Mr. Tomlinson's experiments that, under certain conditions, violent ebullition took place, whilst under certain other conditions it did not. The matter might act in various ways—possibly by disintegrating the mass of water similarly to the tubes of a locomotive boiler. At any rate he thought the results which had been obtained would induce persons to continue the experiments in a more consecutive way than they had been tried hitherto. There was no doubt that effects had been produced by putting strange substances into boilers; some substances appeared to have a much greater effect than others in promoting the flow of steam bubbles, whilst others had no effect at all.—The suggestive paper of Mr. Tomlinson, pointing out the philosophical reasons of many empirical practices, and thereby rendering them more certain processes, is most valuable in a large manufacturing country, where rapid and non-destructive boiling, from the housewife's tea-kettle up to the locomotive engine, is the great element of economy. The source of physical power being heat, the practical application of that power is all important. The best and most efficient application we yet know is through the agency of water. The water is converted into steam, and the heat thus becomes manageable. Every process that can increase the rapidity of steam production decreases the cost and size and risk of boilers. It is not the size of the boiler, but its steam production, that is the measure of its power, and it is quite possible that we shall yet obtain locomotive engines, which, by economising and rendering available their whole heating surface, may be reduced to one-fourth their present size. We shall then get blood horses instead of cart horses to perform our rapid transit. But there is another consideration beyond the steam production, that is, circulation, to extricate the steam. Sediment and deposit in boilers are caused by faulty circulation, just as a similar defect causes diseased deposits in living human or animal bodies. In the boiler and fire-box varying thicknesses of metal, arising from seams of rivets, double and treble overlaps of plates, and irregular exposure of surfaces, cause eddies, instead of a uniform flow, and where the eddies are there are the deposits, gradually shutting out the passage of heat and increasing their bulk, just as sand banks are formed in river and sea channels. A copper teakettle, all formed in one thickness, almost becomes an heirloom in a house by its durability. If that copper tea-kettle were riveted together by projecting rivets and overlapping plates, it would be burnt out by the collection of sediment. There is a thickness of metal through which heat will freely pass, according to its specific quality. If made too thick it will burn down to the proper thickness. A man, famous in his day, one John Hague, a man in his own right of instinctive brain, an engineer, made, amongst other things, dyers' kettles of solid tin, usually about three-eighths of an inch in thickness. One of his customers, finding his kettle wear out too rapidly by stirring inside, determined on having one of double thickness. John Hague remonstrated, but was overruled, and the kettle was made and filled with water, with a fire under it. The metal in contact with the fire began to melt away, and, finally, the thickness was reduced to three-eighths, when it remained stationary. It is probable that some day our locomotive and other boilers will be welded together, without seams or rivets, of the thickness needed for strength and the free transmission of heat, and then they will become as durable as copper kettles. Mr. Tomlinson says he has the greatest horror of patents as a means of seconding philosophical research, and especially under the present laws and practice, and therefore he makes a free gift of his researches to the useful arts. We can easily sympathise with him, No two things can be more at variance than the loving studious nature that follows up researches in the desire for truth and knowledge, and the mere competitive spirit, that cares nothing for truth, but only for such victories as it can achieve by " competent false witnesses " and hired tongue fence. The nature that can do these things has nothing in common with wisdom or philosophy. It is of the wild beast class and order, and worships nothing but the power of the purse, or of that bastard intellectual faculty known as cunning, formerly meaning ability, and now trickery. But Mr. Tomlinson's dislike to these things must not blind us to the evil of suffering, as the first Rowland Hill phrased it, " the devil to have all the good things to himself." There was a time when land could only be obtained and held by the strong hand, but as people became aware that crops could only be obtained by enclosures, and crops were essential to the community, owners obtained, and were confirmed in possession. So also mental labour is essential to the community, and mental labour will only be prosecuted effectually by granting it enclosures—effective enclosures not to be broken into. Were there no copyright in books, books would not be produced, save in few instances by the wealthy. Were there no copyright in art, artists and bookwriters, having little to do, would be inquiring keenly into the rights of other property. The community at large is far more deeply interested in patents than even the inventors, and all the proceeds abstracted from them by uncertain laws are really abstracted from progress. I once talked over this question, as to the feasibility of quick and just judgment as to all the patent cases brought into the law courts, with one of our most competent men, and he gave it as his opinion that there was no mechanical dispute as to practice or principle that could not be decided by two competent brains in half a day, putting evidence of the ordinary class of the circumstantial kind out of the question. The necessity of good patent laws is every day growing, and every day they will be nearer at hand. They are not a monopoly, but the only safeguard against monopoly—the only process whereby brain can be made the equal of capital, as it should be. There is a brain now on the highest judicial seat, which long ago uttered words of conviction as to the possibility of just and simple patent laws, and when that conviction bears fruit, we need not doubt that the originating philosopher will not be forgotten in the scheme of justice to all men working at human progress. What Mr. Tomlinson aims at in his process is to show the law under which steam or vapour may be most rapidly disengaged from masses of water, and his experiments show conclusively that there are conditions under which the steam is retained till it makes a series of violent explosions, and other conditions under which it flows upwards in multitudes of infinitesimal globules through the whole mass. These last conditions are what Mr. Tomlinson calls nuclei—matter which attracts heat, imparts it to the water, and disintegrates the mass. The value of a steam boiler is in proportion to the quantities of fuel it can consume usefully, the heat it can convey into water, and the rapidity of giving out that heat in the form of steam. Therefore, the more diffused are the outlets for the steam into the steam-chamber, the less will be the priming or carrying up of unvaporised water. A steam boiler will be stronger, lighter, less risky, and less costly in proportion to the diminution of its cubic contents; and if a boiler measuring a cubic yard could, by a perfect use of its heating surface and free discharge of steam, consume as much fuel and give out as much steam per hour as a boiler of four yards cube, it would be a great advantage and economy. So far as we know, a given quantity of fuel can only achieve a certain quantity of power by its combustion, but we can by bad arrangements take so long a time in consuming it, that in the case of a locomotive we can only move slowly, and the speed is limited by the rapidity with which we can supply the steam; and the more rapidly this steam can be generated, the less is the necessity for a large mass of water, and magazine of possible explosion. Could we generate power with every stroke of the piston in the exact quantity required, risk of explosion would disappear. In conclusion, he begged to propose a most cordial vote of thanks to Mr. Tomlinson for his valuable paper.

The vote of thanks was passed unanimously and acknowledged, and the proceedings terminated. The experiments referred to in the paper were conducted with perfect success by Mr. Tomlinson and Mr. Hatcher.

DISTRICT SCHOOLS FOR PAUPER CHILDREN.

By George C. T. Bartley, Esq.

The great importance of these schools and the excellent work which they are producing renders it important, especially at this time, when a universal system of education is so much discussed, that their working cost should be better known. Great uncertainty at present exists as to their expenditure, and many districts are unwilling to entertain an idea of forming such schools for their pauper children, fearing that they may be running into endless outlay. None who have seen the schools can doubt of their advantage over the small schools in the unions, and if it can be shown that they are, or may be made, as economical, it will not be long before they exist in every district in the country.

To ascertain with exactness the expenditure is no easy matter, and it is proposed to analyse the annual accounts of the six large district schools at present existing, in the hope that the subject may be well ventilated.

THE CENTRAL LONDON DISTRICT SCHOOL, HANWELL, MIDDLESEX.

The average number of children in the school during 1867–8, the year to which these accounts refer, was 1,051.

I.—Cost of Officers and Servants.

Description of officer.	Salary.			Estimated cost of rations.			Total.			Cost per head for each child at the school.
1.—*General Staff.*	£	s.	d.	£	s.	d.	£	s.	d.	£
Superintendent	200	0	0	33	17	0				
Chaplain	350	0	0							
Clerk to the Board	250	0	0							
Matron	75	0	0	33	17	0				
Superintendent's clerk	125	0	0							
Assistant do.	60	0	0	33	17	0				
Storekeeper	75	0	0	33	17	0				
Cook and assistant storekeeper	35	0	0	33	17	0				
Yardsman (boys)	32	10	0	33	17	0				
Do. assistant	20	16	0	33	17	0				
Do. (girls)	26	0	0	33	17	0				
Gas man	83	4	0							
Sewage man	52	0	0							
Porter	30	0	0	33	17	0				
Housemaid	15	12	0	33	17	0				
Dining-hall woman	9	19	0	33	17	0				
Corridor woman	15	12	0	33	17	0				
	1,455	13	0	406	4	0	1,861	17	0	1·772
2.—*Nurses.*										
Infirmary nurse (boys)	18	4	0	33	17	0				
Do. (girls)	19	10	0	33	17	0				
Ophthalmic do. (boys)	54	12	0							
One nurse	19	10	0	33	17	0				
Three do.	54	12	0	101	11	0				
Five do.	82	0	0	169	5	0				
Eleven do.	171	12	0	372	7	0				
One assistant do.	5	4	0	33	17	0				
	425	4	0	778	11	0	1,203	15	0	1·145
3.—*Medical.*										
One officer	300	0	0							
Assistance	147	2	0							
	447	2	0				447	2	0	·425
4.—*Teachers.*										
Senior master (boys)	155	0	0	33	17	0				
Second do.	85	0	0	33	17	0				
Third do.	55	0	0	33	17	0				
Master (girls)	95	0	0	33	17	0				
Mistress (do.)	49	0	0	33	17	0				
Two do. (infants)	88	0	0	67	14	0				
Three assistant teachers.	120	0	0							
Six pupil teachers and four monitors (boys)	20	7	4	338	10	0				
Five pupil teachers and one monitor (girls)	9	19	4	203	2	0				
	677	6	8	778	11	0	1,455	17	8	1·385
5.—*Industrial Teachers.**										
Bandmaster	85	0	0							
Drill master	70	0	0							
Do. mistress	19	10	0	33	17	0				
Training painter, plumber, and glazier	85	16	0							
Two assistant do.	140	8	0							
Training bricklayer	85	16	0							
Do. blacksmith	93	12	0							
Do. carpenter	85	16	0							
One assistant do.	78	0	0							
Training engineer	65	0	0	33	17	0				
Do. shoemaker	36	8	0	33	17	0				
Five assistants	260	0	0							
Training tailor	62	8	0							
Two assistants	104	0	0							
Training baker	41	12	0	33	17	0				
Assistant	31	4	0	33	17	0				
Training cook	25	0	0	33	17	0				
Do. needlewoman	20	16	0	33	17	0				
Two assistants	41	12	0	67	14	0				
One do.	15	12	0	33	17	0				
One do.	7	16	0	33	17	0				
Training washerwoman	15	12	0	33	17	0				
Laundry woman	19	10	0	33	17	0				
Two assistant do.	31	4	0	67	14	0				
Drying-room woman	15	12	0	33	17	0				
Head washerwoman	15	12	0	33	17	0				
Six washerwomen	80	14	0	203	2	0				
	1,733	10	0	778	11	0	2,512	1	0	2·390
6.—*Farm Servants.†*										
Farm assistant	54	12	0							
Teamsman	52	0	0							
Carter	52	0	0							
Dairymaid	13	0	0	33	11	10				
Two cowmen	104	0	0							
One do.	41	12	0							
Gardener	59	16	0							
Three labourers	156	0	0							
Ploughman	52	0	0							
	585	0	0	33	11	10	618	11	10	·588
7.—*Temporary Mechanics, &c.*										
Various trades	460	14	0				460	14	0	·438
Grand total	5,784	9	8	2,775	8	10	8,559	18	6	8·144

* In considering this item it must be remembered that the work done in teaching the children is remunerative. Thus all branches of trades—as tailoring, shoemaking, plumbing, painting, &c.—required for the inmates and the building, is performed by these monitoral teachers, assisted by the children. The cost of training must, therefore, not be considered so large as it at first sight appears, but a considerable portion should in reality be charged to the clothing of the children and maintenance of the building.

† The farm must be looked upon to a great extent as an industrial school, and these servants may be said to belong almost to the class of industrial teachers.

II.—The Cost of Maintenance.

The exact cost of the amount of food which the children obtain is rather difficult to ascertain from the printed report. The cost of all the provisions is £12,072 7s. 1d., with the addition of an item in the superintendent's account, lumped together with other payments, to the extent of £4,200. Probably this is partly farm produce, and may amount to some £700 or £800. Taking then £12,800 as the total cost, the officers' rations, £2,775, included in item No. 1., must be deducted, leaving some £10,000 to the children's portion, or, as nearly as possible, £9 10s. per head per annum.

III.—The Cost of Clothing.

This item amounts to £1,969 18s. 6d., or at the rate of £1 17s. 5d. per head per annum.

IV.—Miscellaneous Expenses.

This item includes gas, coals for heating purposes, upholstery, glass, and other articles required in keeping up the establishment, and amounts to £4,875 6s. 3d., or £4 12s. 9d. per head per annum.

V.—Farm Expenses.

These charges are for articles required for the keeping up of the farm; they amount to £1,063 13s. 7d., or at the rate of £1 0s. 3d.

VI.—Rent and Re-payment of Cost of Building.

This is one of the largest items in the cost of the school, and will remain so for about 9 years, when both interest and principal will be paid off. The amount last year was £5,965 18s. 4d., or at the rate of £5 13s. 6d. per head per annum. The general summary therefore of the cost of this school per head per annum is—

1. Staff	£8·144
2. Maintenance	9·500
3. Clothing	1·870
4. Miscellaneous	4·637
5. Farm	1·012
6. Rent and redemption of buildings	5·675
Total	30·838

or about £30 16s.

INDIAN ARCHITECTURE.

The following, which is extracted from the *Athenæum*, shows how little attention this subject has received, and corroborates, in a remarkable way, the foresight of the Society in discussing the matter. There is no doubt that the abolition of the East India Company has left the subject of the arts of India without any proper organisation to look after it. The museum in Leadenhall-street was removed and dispersed, and it may be doubtful if it can be revived under the present dual system of Indian government:—

For many years past there lay unnoticed in the stables of Fife-house a mass of old Indian marbles, which had been brought over from Madras, hardly any one knew either when or why. They were broken and uncomely; and if any man had the wit to push inquiries as to what they were and whence they came, he was told they were fragments of an Indian temple of which scarcely anybody in London had ever heard the name. If the inquirer went yet further, he might—or might not—have learnt that these broken stones had been found, a good many years ago, lying on the wharf at Madras, exposed to the wind and rain, and that, after much writing of letters, they had been shipped for England, where they had been tumbled out on the yard of Fife-house. To ask how they came to be lying on the wharf at Madras was like going back to the deluge; yet when curiosity pushed its way backwards, these stones were traced to Mr. Walter Elliot, who, when acting as commissioner at Guntoor, twenty-four years ago, had employed his leisure in grubbing along the green slopes and mounds on the river Kistna, after the fashion then being set by Botta and Layard on the Tigris. Elliot had met with much success in his labours, having unearthed a city and recovered an ancient temple, the details of which were of exceeding richness and importance. Nay, he had actually forwarded his wealth of examples to Madras, in the hope of their reaching London, and making his name immortal. But—alas, for human hopes!—Elliot was no writer. He could not tell his story in a way to arrest the public eye. Amravati was not a biblical city; and, unlike the Tigris, the river Kistna had a foreign sound. The temple which he had found was called a tope; the name and office of which were alike unfamiliar to the English mind. The temple was Buddhistic; and, as Gotama Buddha is not mentioned in the Scriptures, the stones of which his temple had been built in Amravati could not serve to illustrate the form and site of Solomon's temple in Jerusalem. Hence they lay on the wharf at Madras, exposed to wind and rain for a dozen years, until some one happily found that these heaps of stone were in the way; and thought that, as they had cost a bag of money for cartage, they might as well be sent to the India Museum in London. Hence they were shipped from Madras, and brought to London, where, on arrival, they had the fortune to be stored away in the stables of Fife-house, with so much secrecy, that no one soul, beyond the clerks and officers of the Museum, had any knowledge of their existence.

Yet all these years there lay in these waste places of our power, among these broken fragments of stone, as much curious and important history as anything found by our explorers on the Tigris and the Euphrates!

When Mr. Cole was laying out plans for our share in the French Exhibition, he proposed to Mr. Fergusson, as the chief authority on Indian Architecture, that some casts and models of old Indian temples should be prepared under that gentleman's eye. Mr. Fergusson, who fell in with the suggestion, set to work; meaning at first to confine the display mainly to photographic studies of Brahminical and Buddhistic works, backed by four or five casts from the curious and beautiful marbles which had long been shown in the old Indian Museum in Leadenhall-street. These marbles, we need not say, had been greatly admired; and no one will be surprised to hear that good judges thought them so fine as to warrant an artist in going to India to see their fellows. Well, Mr. Fergusson went down to Fife-house, for a quiet study of their comparative merits, with a view to casting those which would best convey a notion of the whole. He had turned them round and round, made plans and drawings, and, in the end, had selected four examples for the caster, when, to his great amazement, the clerk mentioned, "just promiscuously," that there were heaps of such things in the coach-house in the yard. Yes, there they were—shafts, friezes, figures; a world of artistic fragments; some of rare beauty; all of singular interest, lying in a shed, exposed to slush and snow.

Of course, the Indian authorities awoke to a sudden sense of their treasure directly their eyes were drawn to the stable-yard. Dr. Watson and Mr. Griggs, with laudable celerity, came to the rescue. The pieces of stone were now picked up and set in order. The separate slabs were copied. Soon these gentlemen began to find that they had more in hand than a mass of stones. The pieces fitted to each other. It was possible *to build them* up; and as the pile grew higher, it took a wondrous and comely shape. In fact, the old Buddhistic Tope, under these skilful hands, came back, as it were, to life.

Many of our readers will remember the specimens of Indian marbles which were shown in the French Exhibition, along with the rare and costly collection of photographs of Indian buildings. It is doubtful whether England sent to that gathering of the world's best any other series which so strongly engaged the interest of continental scholars.

But this recovery of an ancient Buddhistic temple is far from being all that we have gained from Mr. Cole's happy thought. The recovery is that of an original record; and we have not only got possession of this record, but of its secret. The tope is a religious edifice, and the stones of which it is built are covered with figures—figures of men, animals, trees, and reptiles. They are especially covered with trees and reptiles; that is to say, with figures which appear to be symbols of trees and reptiles.

The fact is not quite new, but it has not heretofore been shown so clearly and completely as *in these remains.* Buddha was an idol breaker. He denounced images and symbols; he prohibited his followers from representing God by any visible shape. His religion was one of contemplation and abstraction; and in his saintly eyes a sign or image of the uncreated and ineffable God was a profanity not to be endured. Yet here, in very early temples, we find the house of God profaned by types and images of what Gotama Buddha himself would certainly have denounced as devil-worship. In fact, these slabs in Fife-house cast a flood of light upon the dark history of Asiatic religions, which are not only curious as regards the past, but important in connexion with the future. Men are governed through their religious feelings; and the first step towards a knowledge of these feelings is a perfect study of their religious rites.

In our opinion, Sir Stafford Northcote acted wisely and economically in ordering these monuments to be photographed and published under the care of so good an antiquarian as Mr. Fergusson, whose production and description of the plates leave hardly anything to be desired.

When it was resolved to issue copies of the Amravati marbles, Mr. Fergusson suggested the addition of some specimens of the yet more ancient tope of Sanchi, of which there happened to be a capital series of drawings, made by Colonel Maisy, of the Bengal Army, in the India Museum. The Tope of Sanchi dates from the first century of our era, that of Amravati from the fourth. This additional proposal was accepted by Sir Stafford; and the consequence is, that we have an excellent account, with specimens, of Buddhistic architecture in India nearly coeval with the Temple of Herod and with the earliest Christian edifices in Byzantium. All these things are good in their several ways; but the history of architectural art is of less importance than the history of religious ideas; and it is for the evidence which they present of the early intermingling of pure Buddhistic ritual with the ancient worship of the land—in its two most antique forms of tree worship and serpent worship—that these pictures of Sanchi and Amravati will be most welcome to serious students of our human history.

We congratulate all the parties concerned in this book—Mr. Fergusson, Sir Stafford Northcote, Dr. Watson, and Mr. Griggs.

TECHNICAL INSTRUCTION.

The Committee of Council on Education, on December 21st, 1867, passed an important minute for the encouragement of scientific instruction. Its leading features are as follows:—

"In order to assist the artisan classes who may show an aptitude for scientific instruction, my Lords resolve to aid local efforts in founding scholarships and exhibitions. The scholarship is intended to maintain a student while remaining at the elementary school, and the exhibition to support him while pursuing his studies at some central institution where the instruction is of a high grade."

"1. The Science and Art Department will make a grant of £5 towards the maintenance of a deserving student (between twelve and sixteen years of age), to the managers of any elementary school, who undertake to support him for one year, and subscribe £5 for that purpose.

"2. The same Department will grant £10 per annum towards maintaining a student (of like age) at an elementary school, who has already passed (1st grade) in two subjects of drawing and one of science.

"3. The same department will grant £25 per annum (for one, two, or three years,) to managers of any educational institution, or local committee who will raise a like sum, for maintaining a student at some college where scientific instruction of an advanced character may be obtained. The exhibition must be awarded in competition in one or more branches of science at the May examination of the Science and Art Department."

In accordance with the intentions of this minute, it is proposed to graft on to the science and art instruction already imparted at the Training College for Schoolmasters, Culham, Oxon, such higher branches as are required for fitting persons to be teachers of technical schools throughout the country. The proximity of the college to the University of Oxford (where the scientific museums, schools of art, and a large body of scientific professors, afford unusual advantages for high education), seems to mark this institution as peculiarly adapted for such an undertaking.

Classes were opened on February 1st, under highly qualified masters, in all branches of practical drawing, mathematics, mechanics, hydraulics, electricity, chemistry, geology, applied sciences, &c., &c., to prepare students for the examination in May next, when several exhibitions of £10 each (to meet those offered by the Committee of Council) will be offered for competition. After May next, a separate department will be opened for carrying on students mainly in those branches of study which will render them efficient teachers of technical instruction.

All further information will be afforded, and all suggestions from Chambers of Commerce, local committees, &c., gladly received by the Rev. James Ridgway, M.A., F.S.A., Principal of the College.

Fine Arts.

International Fine Art Exhibition at Munich.—It having been reported that the Munich Exhibition, already announced in the *Journal*, would take place this year, M. Schwab, Bavarian Consul in Paris, and Commissioner for the coming Exhibition, has written to the *Moniteur des Arts* stating that there is no truth in such rumours, that the doors of the Exhibition will be opened on the 1st of August, and closed on the 1st of October, and that the government, the artists of Bavaria, and the town of Munich, will do all in their power to give eclat to the Exhibition, and a worthy reception to the artists from foreign countries.

Manufactures.

Silk Culture in California.—The *San Francisco Herald* says:—"Those engaged in the culture of silk in California have growing no less than 1,175,000 mulberry trees. They are apportioned as follows:—Los Angeles 50,000, Santa Barbara 100,000, Santa Clara 150,000, Nevada 50,000, Sacramenta 425,000, Yolo 400,000. The total production of cocoons in 1868 amounted to 1,350,000, equivalent to 1,917 pounds, allowing 704 cocoons to the pound, representing a cash value of 3,676 dols. 75 cents. To be added to this was the egg crop of 7,350 ounces, commanding in the market 8 dols. per ounce, amounting to 10,800 dols. There will be a vast increase in the production of cocoons this year, as three cocooneries will hatch 600 ounces of eggs, sufficient to produce 18,000,000 cocoons."

Commerce.

Imports of Coal to France.—The imports of coal and coke to France during 1868 were as follows:—

	Coal. Tons.	Coke. Tons.
From Great Britain	1,885,000 ..	3,800
„ Belgium	3,718,000 ..	448,200
„ Germany	1,389,000 ..	212,700
„ Other countries ..	1,000 ..	300
Totals	6,992,000	665,000

Letter Copying.—MM. Niepce de St. Victor and Lavater give the following method of producing several copies of manuscripts, whether fresh or of old date: Let the copying paper be first lightly wetted with a sponge in the ordinary way, and after the copy is made submit it to the vapour of ammonia, which will bring out the writing with great distinctness. Another plan is to wet the paper with a solution of sugar, glucose, sugar of milk, honey, or other mucilaginous, gelatinous, or resinous matter. Paper thus wetted will copy writing in ordinary ink. This is in fact only using the saccharine matter in connection with the paper, instead of introducing it into the ink in the old fashion, but it has the great advantage of leaving the latter limpid, or in other words of doing away with the necessity for special copying ink. The receipt is so simple that any one can test its value for himself.

Colonies.

Victorian Gold.—An official report has been prepared showing the amount and value of the gold obtained and exported during the first nine months of 1868. The yield of gold was 1,274,661 oz. 9 dwt., of which 1,248,704 oz. 18 dwt. were exported. The figures show a decrease on the returns of 1867 on every quarter. The number of miners employed was 63,482. Machinery having an aggregate of 20,683 horse-power was worked on the various fields, and the gross value of mining plant was £2,133,855. There were 837¼ miles of auriferous ground already worked upon, and 2,561 distinct quartz reefs were proved to be gold bearing. The lowest price given for gold was £3 per oz. for some from Gipps Land, and the highest was £4 2s. 3d. for gold taken from the central division of the great Ballarat fields.

Notes.

◆

The Fell Railway on Mont Cenis.—The receipts for the week ending 18th March of the Mont Cenis summit railway, amounted to 22,962f. The total receipts from the beginning of the year to the 18th March were 229,683f.

The Mont Cenis Tunnel.—During the first fortnight of March the length driven at the Mont Cenis tunnel was 67·20 m., of which 40·10 were on the Italian side, at Bardonnèche, and 27·10 on the French side at Modane. The position of these works up to the 15th March was the following:—

Lengh driven at Bardonnèche	6,514·70
„ „ Modane	3,939
Total length driven	9,453·70
Remaining to be driven	2,766·30
Total length of tunnel	12,220

Correspondence.

◆

Diamonds at the Cape. — Sir, — A letter by Mr. Emanuel on this subject, which appeared in your *Journal* some time since, and which has been copied into the Cape papers, contains some statements to which I feel called upon to reply. That gentleman's "natural desire" to discover fresh sources of diamonds is evidently counteracted by the still more natural desire to keep up the prices of those derived from existing mines. The number of diamonds which have already been found in this neighbourhood is upwards of thirty, of an aggregate value, I believe, of about £4,000. A few of these, some seven or eight, I think, have been found on the colonial side of the Orange river, but the great majority have come from the further side of the Vaal river, where they have been discovered in the territories of independent native chiefs, and have been picked up by naked savages, under circumstances that preclude the possibility of fraud. The assertion that all the colonial diamonds have been found on one farm, belonging to a Dutch farmer, is untrue; and though it may seem plausible enough in England to say that the diamonds were placed by the Orange River farmers on their farms to raise their value, anyone acquainted with these people would know it to be too absurd to even require contradiction. Though I do not pretend to be profoundly versed in geology, I venture to dispute Mr. Gregory's assertion that the "whole of the country visited is of volcanic origin," the prevailing formation throughout the whole of the great plateau north of the Sneeuwbergen to the Orange river being well stratified sandstone, though trap rocks protrude everywhere, in fact, precisely the state of things described by Mr. Nicolay as existing at the Brazilian diamond mines. Sandstone is the stone used in Hope Town for building purposes, as Mr. Gregory himself admitted to me whilst here. The conglomerate mentioned by Professor Tennant at the same meeting, exists abundantly here; and I offered to take Mr. Gregory himself to see it, but he declined to go. It consists of rolled quartz, pebbles of various sorts, chalcedony, agates, quartz crystals, bloodstone, lydian stone, &c., &c., fixed in a matrix of sandstone, and it rests on the regular sandstone formation. The minerals mentioned by Mr. Gregory as usually associated with diamonds might very likely be found if proper search were made for them. He spent a fortnight in making the journey of 120 miles beyond the Orange river, and never visited one spot where a diamond has actually been said to be found; but in the case of a substance, the origin of which is so obscure as that of the diamond, their absence is probably of small importance. With respect to Mr. Gregory's opinion about the gold-fields of South Africa, it may perhaps be sufficient to state that he was never within 600 miles of them. That very rich gold quartz exists there, no one who has seen the specimens brought down can have any doubt; and alluvial gold has recently been discovered; but whether the latter exists in sufficient quantity to pay, the practical digger can alone determine.—Yours, &c., E. Muskett, M.D., District Surgeon of Hope Town.

Hope Town, February 4, 1869.

To Correspondents.

◆

Errata.—In *Journal* for March 26, p. 325, in the remarks of Mr. Horne, for "sedar" read "sirdar;" and for "a pound of *eleven* ounces," read "a pound of *sixteen* ounces."

MEETINGS FOR THE ENSUING WEEK.

Mon......Society of Arts, 8. Cantor Lectures. Mr. John Anderson, C.E., "On Applied Mechanics."
Social Science Assoc., 8. Jurisprudence Department. Consideration of the "Bill to Amend the Law with respect to the Property of Married Women."
R. Geographical, 8½. 1. Capt. T. G. Montgomerie, "A Pundit's Journey to the Gold-fields of Thibet." 2. Mr. T. Douglas Forsyth, "On the Transit of Tea from North-west India to Eastern Turkistan."
Medical, 8.
Tues ...R. Medical and Chirurgical, 8½.
Civil Engineers, 8. Mr. T. N. Kirkham, "Experiments on the Standards of Comparison employed for Testing the Illuminating Power of Coal Gas."
Photographic, 8.
Ethnological, 8. "On the Ethnology and Archæology of North America." 1. Prof. Huxley, Opening Address. 2. Mr. Wm. Blackmore, "Notes on some of the principal Tribes of the Indians of the United States, with a brief Account of the late Indian War." 3. Dr. A. W. Bell, "On the Aztec Tribes of New Mexico."
Royal Inst., 3. Prof. Grant, "On Stellar Astronomy."
Wed ...Society of Arts, 8. Mr. E. M. Underdown, "On Spain, Commercially and Economically considered."
R. United Service Inst., 8½. Mr. George Campbell, "The North-west Frontier of India."
Geological, 8. 1. Mr. M. Morgans, "On a Peculiarity of the Brendon-hills Spathose Iron Ore." *Communicated* by Mr. W. W. Smyth. 2. Mr. R. B. Grantham, "On the Broads of Norfolk." 3. Messrs. S. V. Wood, jun., and F. Harmer, "On Intraglacial Erosion near Norwich." 4. Mr. E. J. Beor, "On the Lignite Mines of Podnernuovo." 5. Dr. F. Ruschhaupt, "On the Salt Mines of St. Domingo." Communicated by Sir R. I. Murchison.
Graphic, 8.
Microscopical, 8. 1. Dr. Lionel Beale, "On Protoplasm and Living Matter." 2. Mr. W. T. Suffolk, "On the Proboscis of the Blowfly."
R. Literary Fund, 3.
Archæological Assoc., 8.
Royal Inst., 3. Prof. Tyndall, "On Light."
Thur ...London Inst., 6.
Royal, 8½.
Antiquaries, 8½.
Linnæan, 8.
Chemical, 8.
Numismatic, 7.
Royal Society Club, 6.
Society of Fine Arts, 8. Lecture by Dr. C. Dresser.
Fri ......Philological, 8½.
Royal Inst., 8. Mr. W. Carruthers, "On the Cryptogamic Forests of the Coal Period."
Sat ......Royal Inst., 3. Mr. A. Geikie, "On the Origin of Land Surfaces."

PARLIAMENTARY REPORTS.

SESSIONAL PRINTED PAPERS.

Par. Numb. *Delivered on 20th March*, 1869.

51. Bill—Sea Fisheries (Ireland).
54. „ Land Tax Commissioners' Names.
58. „ Brazilian Slave Trade.
59. „ Sea Birds Preservation (amended).
Public Petitions—Eighth Report.

Delivered on 22nd March, 1869.

2. (5.) Railways Abandonment—Warrant of the Board of Trade.
82. Mechanics' Institute (Grants to Elementary Classes)—Return.
84. Admiralty—Return of the Distribution of Business.
87. Public Accounts—First Report.

Session 1868.

433. (5.) Endowed Charities (County of Dorset)—General Digest.

Delivered on 23rd March, 1869.

11. Bill—Valuation of Property.
93. Cricksea Bridge—Report.

Session 1868.

500. Navy (Channel Fleet)—Report.

Delivered on 24th March, 1869.

60. Bill—Grand Jury Cess (Ireland).
83. Official Appointments (Ireland)—Return.
89. Naval Officers—Instructions.

Trades Unions and other Associations—Eleventh and Final Report of Commissioners.

Public Petitions—Ninth Report.

Delivered on 25th March, 1869.

45. Bill—Real Estate Intestacy.
53. ,, Metropolitan Poor Act (1867) Amendment.
92. Abyssinia—Explanation.

Delivered on 27th March, 1869.

85. Sligo Borough Election—Minutes of Evidence.
86. Homerton Congregational Schools—Preliminary Report.

Delivered on 31st March, 1869.

74. (I.) Asylums (Metropolis)—Return.
94. Publichouses and Beerhouses—Return.
95. Public Education—Account.
96. Education (National Society)—Letter.
101. Lord Lieutenancy (Cumberland and Westmorland)—Commissions.
106. Mail Contracts—Report.

Session 1868.

151. (XII.) Trade Accounts (Foreign Countries) (Belgium, Holland, France, and Austria), 31st December, 1868.

Delivered on 1st April, 1869.

61. Bill—Imprisonment for Debt.
18. Consolidated Fund—Abstract Account.
23. Metropolitan Board of Works—Report.
46. (I.) Trade and Navigation Accounts (28th February, 1869).
62. Navy—Statement of Savings and Deficiencies.
88. New National Gallery—Correspondence.
102. Maynooth College—Returns.

Delivered on 2nd April, 1869.

90. Beverley Election—Minutes of Evidence.
98. Poor Law (Medical Relief)—Returns.

Patents.

◆

From Commissioners of Patents' Journal, April 2.

GRANTS OF PROVISIONAL PROTECTION.

Account books, &c., indexes of—860—J. Booth.
Artificial fuel—753—J. H. Johnson.
Artificial stone blocks—884—J. H. Johnson.
Blinds and shutters, apparatus for raising, &c.—777—P. B. O'Neill and W. H. H. McNeight.
Boots, &c., application of elastic fillets, &c., to—880—J. Macintosh.
Bottle stoppers—872—J. J. Hicks.
Buttons or studs—765—E. Pritchard.
Capsules—747—W. Betts.
Carbonate of potash—819—C. F. Claus.
Carriage shafts, &c., joints of—805—W. and C. S. Catt.
Cotton, &c., machinery for preparing and spinning—799—O. Whittaker and H. and I. Wallwork.
Envelopes—876—J. Nicol.
Fabrics, textile—846—S. R. Wybrants.
Fire-arms and ordnance—757—F. R. Aikman.
Fire-arms, breech-loading—783—W. R. Lake.
Fire-arms, breech-loading—793—J. R. Cooper.
Fire-arms, repeating—779—J. Thomas.
Fire-arms, repeating—838—A. Albini.
Fire-bricks, substitute for—627—J. Cliff.
Fires, extinguishing—858—W. H. Phillips.
Flax, &c., transmitting rotary motion to machinery for preparing and spinning—868—J. Combe and J. Barbour.
Furnaces—693—C. Fairbairn.
Furnaces—848—F. D. Nuttall.
Gas meters—749—J. Bathgate.
Gas, purifying—870—E. Stacey and J. Thomson.
Hats, &c.—817—F. Gillham.
Healds and heald frames—789—C. D. Abel.
Indigo, carmine, &c.—439—H. B. Binko.
Iron and steel—836—J. Thomas, W. Bacon, and H. Groves.
Jute, &c., preparing for spinning—696—P. Buchan and A. Guild.
Liquids, measuring—856—H. E. Newton.
Marine engines, governors for—854—F. E. Duckham.
Metal, apparatus for making holes in—882—C. de Bergue.
Nitro-glycerine, protecting for conveyance, &c.—886—J. Horsley.
Paper and textile fabrics—781—J. and W. Thomlinson.
Paper-making—773—H. C. Bartlett and A. G. Southby.
Phosphate of lime, &c.—761—E. F. R. Lucas.
Pictures, &c., hanging—751—W. E. Newton.
Ploughs—767—J. Cooke.
Powders, compressing into pellets—807—J. James.
Purses, &c., attaching to the pockets or clothing to prevent loss or robbery—878—G. Blanche.
Railway brake and coupling apparatus—771—J. Duffey.
Railway carriage doors, &c.—652—R. Wright.
Railways—351—W. E. Newton.
Railways—842—S. Fox.
Salt water, &c., recovery of salt from—769—C. E. Brooman.
Sanitary purposes, apparatus for—743—W. Wells.
Sewage, preparing for irrigating land—791—J. G. Jennings.
Sewage, straining—809—B. Latham.
Sewing machines—801—W. Campion.
Ships—840—J. Jack.
Signal lanterns—745—W. H. Clapp.
Table cutlery—866—E. G. Reuss.
Telegraph wires, sustaining and insulating—797—W. A. Lyttle.
Telegraphs—733—J. Sax.
Tobacco—763—J. Porteous and H. Gibson.
Tobacco, twisting—862—G. Lauder.
Toothed gearing—852—W. L. Wrey.
Tuyeres—850—H. Whitehouse and W. Probert.
Umbrellas, &c.—803—L. Engel.
Walls, &c., preserving—723—R. M. Caffall and D. Miller.
Water cocks or valves—785—J. Henderson and T. Brown.
Waterproof overshoes—844—W. R. Lake.
Wheels, constructing—864—W. G. Crossley.
Yeast, preserving for manuring purposes—741—J. B. Bernier.

INVENTIONS WITH COMPLETE SPECIFICATIONS FILED.

Blowing apparatus—940—W. R. Lake.
Electric clocks—919—H. A. Bonneville.
Horse-shoe nails—941—W. R. Lake.
Oil, &c., pressing—915—W. R. Lake.
Paper-folding machinery—904—W. R. Lake.

PATENTS SEALED.

3009. J. F. G. Kromschroeder.
3011. D. Crichton, W. Donbavand, and D. Crichton.
3015. A. Thorpe.
3022. A. Monsnergue.
3024. R. F. Drury and J. E. and W. G. Walker.
3027. T. C. Parson, jun.
3031. J. Rogers.
3034. E. A. Cowper.
3040. E. T. Bellhouse and W. J. Dorning.
3041. E. Simons.
3043. J. R. Wigham.
3047. R. Ramsay.
3050. J. G. Willans.
3052. J. Jeffreys.
3054. F. P. Warren.
3067. W. Estor and C. T. Pearce.
3068. W. Richards.
3072. J. Chaudron.
3076. T. Sagar and T. Richmond.
3090. M. P. Manfield.
3092. A. MacMillan.
3107. B. Walker and J. F. A. Pflaum.
3120. C. D. Abel.
3131. F. A. Le Mat.
3150. H. Hudson.
3158. A. Robins.
3168. R. M. Marchant.
3169. W. C. Church.
3189. B. Hunt.
3191. C. Whitehouse.
3225. H. Warner.
3237. A. B. Bérard.
3238. R. Dowling.
3260. H. E. Newton.
3313. J. Heaton.
3321. S. Sharrock.
3469. C. K. Bradford.
3486. W. Low and G. Thomas.
3634. J. Heaton.
3643. D. Greig and J. Fernie.
204. J. Wilkins.

From Commissioners of Patents' Journal, April 6.

PATENTS SEALED.

3060. E. T. Hughes.
3061. W. Rossetter.
3074. J. M. Gray.
3079. J. H. Johnson.
3081. J. Steel.
3084. J. Arnold.
3100. E. Evans.
3106. W. T. Read.
3111. F. Barnett.
3112. T. Merz and G. Thomson.
3114. S. J. Maccarthy.
3115. F. A. Abel & E. O. Brown.
3154. W. E. Gedge.
3166. T. Vicars, sen., T. Vicars, jun., and J. Smith.
3226. C. MacMillan.
3235. T. Carr.
3244. M. Sautter.
3245. M. Sautter.
3352. M. Sautter.
3387. J. H. Johnson.
3440. E. Haas.
3465. H. E. Newton.
3603. J. Sincock.
3635. W. Naylor.
3649. A. V. Newton.
3653. W. Betts.
138. R. Craig.
195. C. J. Chubb.
214. J. Millward.
222. J. M. Merrick, jun.
275. N. C. Szerelmey.
281. S. Smith.

PATENTS ON WHICH THE STAMP DUTY OF £50 HAS BEEN PAID.

921. J. Davis.
922. J. Davis.
926. E. T. Hughes.
959. W. Betts.
986. W. Cole.
992. J. Young.
1048. W. Clark.
955. G. P. Wheeler.
1000. W. Clissold.
1007. J. Foster and J. Hollinrake.
1032. J., J., and J. Crabtree.
962. W. Howitt.
1029. W. Young.
1212. J. C. Pearce.

PATENTS ON WHICH THE STAMP DUTY OF £100 HAS BEEN PAID.

897. R. C. Ransome.
901. J. M. Clements.
917. E. Hartley, G. Little, and J. Hinchcliffe.
940. G. Bower and J. Qualter.
966. W. E. Newton.
1008. S. Farron.
957. L. Lindley and F. Taylor.
967. W. E. Newton.
988. J. Watremez and A. Kloth.
939. R. Morton.
956. T. Silver.